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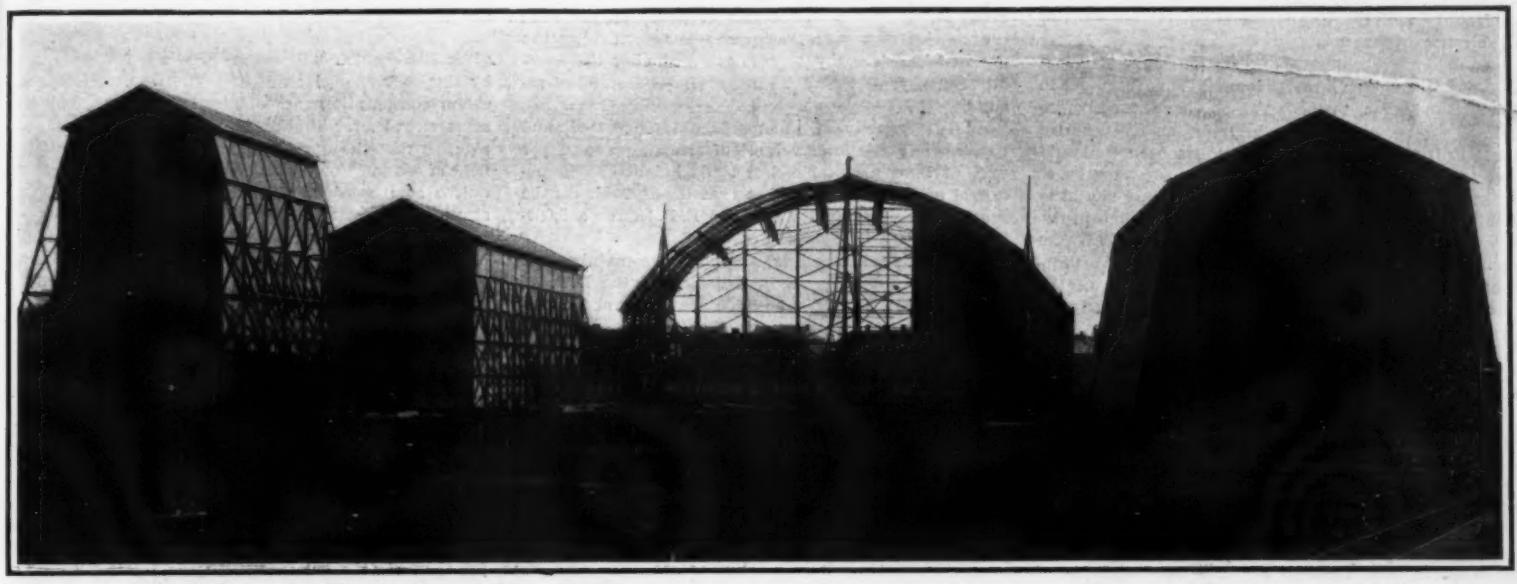
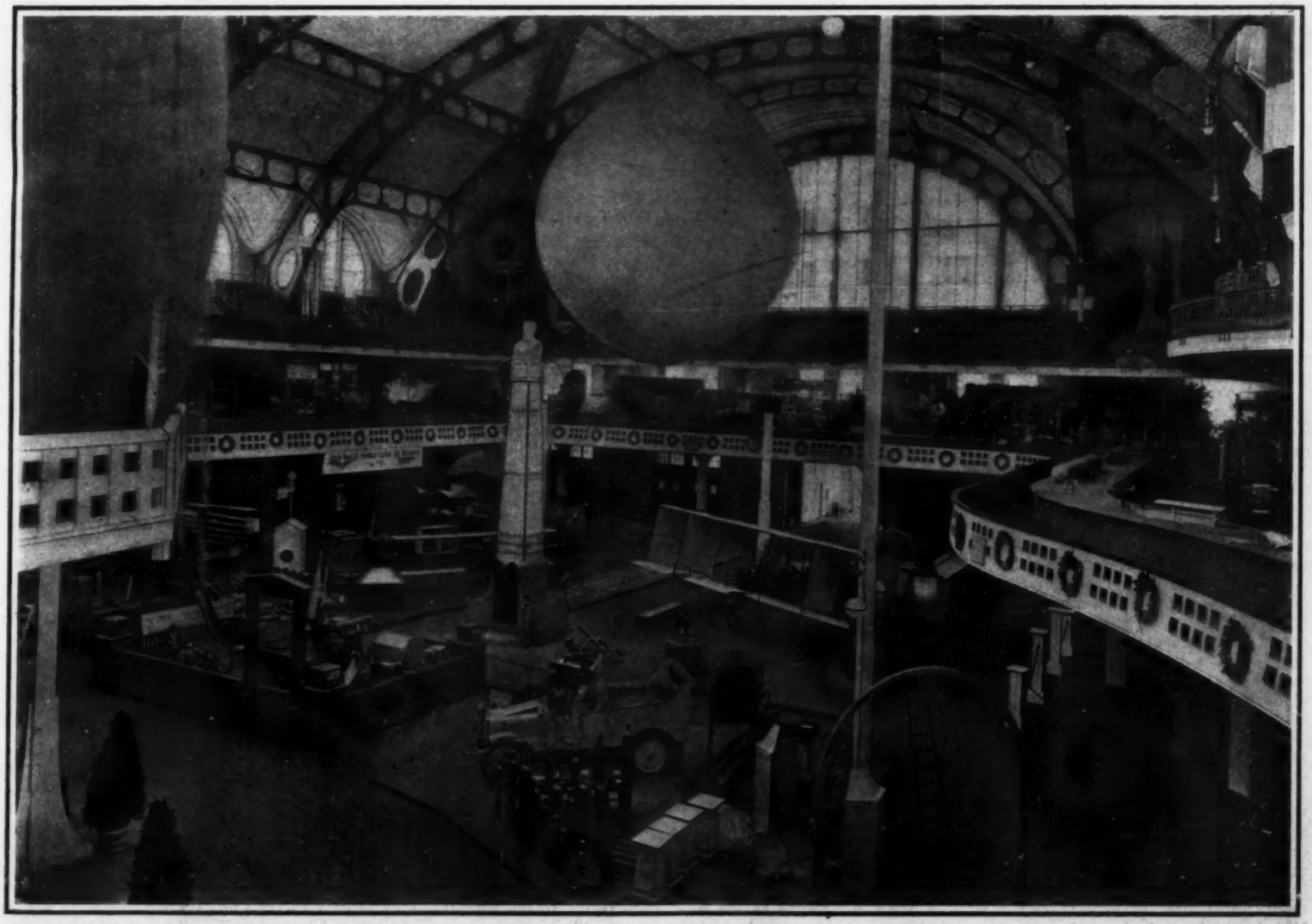


THE AIRSHIP SHEDS AT THE FRANKFORT AERONAUTICAL EXPOSITION.



ONE END OF THE EXHIBITION HALL, SHOWING BALLOONS, AEROPLANES, AND BALLOON GUNS AND AMMUNITION.

On a lofty pedestal, dominating the hall, is a bust of Lilienthal. On one of the balconies, plainly visible in this view, is an exhibit of aeronautic wearing apparel.

THE AERONAUTIC EXPOSITION IN FRANKFORT.—[SEE PAGE 121.]

STEAM TURBINES.

A REVIEW OF THEIR DEVELOPMENT.

The theoretical principles governing the steam turbine have received world-wide scientific investigation during recent years, and are now commonly known. The production of commercially successful designs, however, has proved a difficult problem, but encouraged by the success attained by the Hon. C. A. Parsons, many determined and costly attempts have been made in Europe and America to apply these theoretical principles to the creation of new types of turbines. A few years ago new types were being announced in rapid succession, and in many cases the results claimed to have been actually obtained were such as to place the reciprocating steam engine entirely out of all electrical generating work, while many boldly talked of its total elimination from the ranks of prime movers. Since then great advances have been made by trial-and-error methods which have largely increased our knowledge, though mainly on the negative side. Still this is all gain, for it has been well said that in knowing what not to do lies seven-tenths of the solution of all problems. These developments have been reported and illustrated from time to time in the technical engineering press and in papers read before engineering societies, but a consideration of the problems to be solved, when viewed in the light of the results attained by these attempts, is particularly instructive.

The turning effort of a steam turbine is obtained by the impulse or reaction of the steam in passing through the moving blades, and all designs embody one or both of these methods. From a mechanical and operating standpoint, those turbines operated solely by impulse have a decided advantage over those operated by reaction, owing to the greater clearances which can be allowed between the blade tips and the cylinder and spindle. Those operated by reaction, however, have led the way in obtaining low steam consumption, and consequently the disadvantages of small clearances have been accepted. Although equally good steam consumptions are claimed for other designs, yet the wider application and commercial success of the Parsons design by different builders, both in Europe and America, certainly entitle it to the first position. It is impossible to obtain speeds of rotation suitable for a prime mover unless gearing or compounding be adopted, and the object of all the attempts has been to obtain some method of compounding which shall give as low a steam consumption as that obtainable with the Parsons design while avoiding the mechanical disadvantages attached to that design.

From the operating standpoint the sole objection raised to the Parsons design is the possibility of blades stripping or dummies seizing. Turbines have been run for long periods, both non-stopping and also for the usual daily service, without any such troubles, but the feeling of being continually on the edge of a precipice was for a long time the predominant feature of those who had charge of the running of plants, and accounts for the number of spare sets installed. It is easy to avoid all possibilities of fouling by giving sufficient clearance, but as an increase of ten thousandths of an inch on the dummies will cause a noticeable addition to the steam consumption, the minimum clearances have to be accepted. With increased experience these troubles have been greatly reduced, but the possibility remains and keeps alive the feeling of distrust.

The commercial objections raised to the reaction turbine are that its application is limited between somewhat narrow limits, and that owing to the multitude of blades and the accurate workmanship required, the manufacturing costs are comparatively high. The primary difficulty in designing is the necessity for having the whole of the area between cylinder and spindle, minus the blade sections, available for the passage of steam. This fact, coupled with the speed of rotation and the capacity required, are the determining features of the whole design. It must be clearly understood that the problem is to proportion properly steam and blade velocities and steam passages.

For instance, take a 1,500-kilowatt set running at 1,500 R. P. M. and let the steam pressure, temperature, and vacuum be such that we should expect a steam consumption of 18 pounds per kilowatt-hour. Let a ratio for blade speed divided by steam speed of 0.6 be adopted, and the only remaining choice is the blade speed, which must be fixed to give a suitable first blade height for the volume of steam consumed at the velocity fixed by the ratio decided upon. The higher the blade speed is, the fewer will be the number of rows of blades required, because more B. T. U.'s will be given up per row; but the blades must not be very short or the tip clearance becomes too great a percentage of the total area. Neither must they be excessively long, or the difference in spacing at the root and tip becomes excessive. The figures assumed are common in practice, and work out to a successful design.

Now suppose that it is desired to run at 750 R. P. M. Then to retain the same blade speed the diameter must be doubled. This doubles the circumference, so that only one-half the former blade height is required, which makes the blade too short. Consequently a lower blade speed must be adopted and the diameter reduced. This, in turn, increases the number of rows required, as less B. T. U.'s will be given up per row, especially if the same ratio be retained, making the machine considerably longer, and reducing the overall efficiency, so that a higher steam consumption results.

As the capacity of the machine is increased, and consequently the total volume of steam consumed per unit of time, a suitable first blade height can be obtained on large diameters, so that the R. P. M. can be reduced, bringing it down to 750 R. P. M. for a 5,000-kilowatt set.

As turbine-driven electrical plants are mainly A. C. sets, the periodicities required determine the R. P. M., so that either 750, 1,500 or 3,000 are usual, and consequently limit the designing to that extent.

At the exhaust end this difficulty is not met with, but rather the reverse, i. e., to get sufficient area for steam passage without excessively long blades. A mean blade velocity in the region of 350 feet per second is usually adopted, and owing to the large volume of steam at low pressures the blade tip clearance under any circumstances is but a small percentage of the blade height. The intermediate blading is determined by that at the ends, the increases in diameter being made to suit the increasing volumes of the steam.

To overcome the difficulty at the inlet and high-pressure ends, trials have been made with only a small part of the circumferences bladed, and the remainder filled with a solid strip. Special thick blading has also been tried, but owing to the increased friction and eddy current losses set up, in addition to the tip leakage on the increased diameter, no success has been obtained with either arrangement. The speeds of rotation possible with electrical generators permit of successful designs being produced for units of the present day usual capacities, but for very small units the turbine is severely handicapped when compared with the steam consumption and cost of a double-acting quick-revolution steam engine. Centrifugal pumps and air compressors for large volumes at low pressures have been developed for direct connection to turbines running at similar speeds to those of electrical generators; but for such speeds and horse-power capacities as those required for rope or belt driving of mills, etc., the Parsons turbine cannot compete with the reciprocating steam engine. It can be built to meet those conditions, but the steam consumption under such conditions is prohibitive. In marine work the propeller dominates the whole question, and with our present knowledge the classes of vessels to which propellers running anywhere near 700 or 800 R. P. M. can be successfully fitted are extremely limited.

For speeds approaching the usual practice it is only when large powers are required, and consequently when large volumes of steam per unit of time are passing, that successful designs can be produced. The Parsons design has now had a lengthy and extended commercial service, so that it has become standardized over a considerable range of application, and, except in constructional details, there is little likelihood of improvement.

With a turbine operated solely by impulse, the area for steam passage can be restricted to only a part of the circumference. Consequently, the blade speed for any given R. P. M. is not limited by the volume of steam passing per unit of time, as in the reaction type. In the compound impulse turbine developed by Prof. Rateau, several wheels, each carrying one row of blades, are mounted on the same shaft and inclosed in separate chambers. The number of chambers and blade velocities are so designed that each row of blades absorbs the whole of the velocity acquired by the steam in passing from one chamber to the next. In the early designs the blade velocity ranged from about 230 feet per second at the H. P. end up to 360 feet per second at the L. P. end. Owing to the number of stages required with these velocities, and the necessity for keeping the shaft diameter down to reduce leakage where it passes through the diaphragms, two cylinders were necessary, because the bearing centers were too great for the shaft diameter. In later designs the blade velocities have been increased, so that less stages are required, and they can be all put into one cylinder, thus reducing length and cost.

The clearances over blade tips, and axially between faces of moving blades and stationary guide blades, are from 1/16 inch upward, so that fouling is practically out of the question. The troublesome point is where the shaft passes through the diaphragms. Any sagging or whipping of the shaft causes rubbing, with consequent heating and seizing. Some makers state that, with shafts of sufficient diameter to prevent all possibility of sagging between the bearings, and with ample clearance, the leakage is not of much account. Obviously, from the operating standpoint, it is a mistake to cut clearances fine or introduce baffling devices here which will nullify the advantages gained by large blade clearances. The most economical steam consumptions are obtained with practically the same R. P. M. for similar units as in the Parsons design, so that the application is restricted to a similar field of work. For low speeds the many chambers required so increase the internal losses as to make the steam consumptions prohibitive. The number of blades are but a fraction of those in a Parsons turbine, and owing to the large clearances such accurate workmanship is not required, so that the manufacturing costs are stated to be less than with that design.

The Zoelly turbine is on exactly the same principle as the Rateau, but in the early designs a higher blade velocity of about 590 feet per second was adopted, so that the number of stages was reduced to ten. Even then two cylinders were used, so that a small diameter shaft could be employed to reduce the leakage area. In some designs the first few rows had the steam inlets arranged tangentially, and the moving blades made double, so that the jet was discharged on both sides in the manner of a Pelton wheel. The object of this was to obtain a greater reversal of the jet than can be obtained with the inlets radial, and so enable a higher steam velocity to be used. With the radial inlets a special design of spacing piece between the moving blades is used to increase the area of the steam passage, as the velocity of the jet falls off in passing through the blades, and to allow for the reduction of area due to the acuter angle of discharge. The constructional details differ somewhat, but as many firms have taken up the manufacture of this type on the Continent, the differences in the two designs have tended to be eliminated. The general practice appears to be to adopt a blade speed of about 400 feet per second for the H. P. end, with 490 feet to 500 feet per second for the L. P. end, the L. P. end being increased in diameter to allow for the increased steam volume. Also to put all stages in one cylinder, and to make all the steam inlets radial. General opinion is that shrouding is of no value in respect of steam consumption, but it is fitted to protect the blades during handling for erection, etc.

Owing to the attractive features from the operating standpoint, and the good steam consumptions obtained, several British firms have obtained licenses for the manufacture of this type, and as several sets of varying sizes up to 6,000 kilowatts are on order or installed in various British power houses, convincing proof of results should shortly be available. Sufficient experience has been obtained to render any great step forward in the general design of this type improbable, and it is only in constructional details, and proportioning of the steam inlets and blading, that improvement in steam consumption may be obtained.

In the Curtis design the advantages of the impulse type are retained, and at the same time an attempt is made to get around the troublesome features involved in the many stages of the Rateau turbine. The early designs had only two stages, with four rows of moving blades in each stage, with a fixed blade between each pair of moving blades to direct the jet back again on to the next row. This necessitated the reversal of the jet seven times, and involved its traveling for a considerable distance before it got through the blading.

Taking a saturated steam pressure of 150 pounds gage and 28 inches of vacuum, and assuming that the work is shared between the two stages, then the velocity of the jet leaving the nozzle will be about 2,800 feet per second. The blade velocities were about 350 feet per second. Owing to the friction caused by this high jet velocity and the many reversals, the jet did not remain compact, but broke up and expended its energy in eddy currents and friction instead of passing through and imparting it to the moving blades. Consequently the last rows acted more as brakes than in helping to drive.

Later designs had two stages with three rows of moving blades per stage, while later still this has been increased to four and five stages, with two rows

per stage. With four stages the jet velocity leaving the nozzle would be about 2,000 feet per second—on the same basis—while the number of reversals in passing through the blades is reduced to three, and the distance traveled to about one-half. The blade velocities remain the same as before. The jet keeps more compact, and imparts its energy to the moving blades more efficiently under these conditions, giving a better steam consumption, although there are now twice the number of disks revolving in separate chambers, with consequently a much greater area for skin friction. The skin friction of disks, however, is much less than the brake action of inactive blades. Recent reports from America state that by replacing the early designs by machines of the latest type, an improvement in steam consumption of upward of 30 per cent is obtained, presumably with the same conditions of steam and vacuum.

With more than one row of moving blades, shrouding does improve the steam consumption, because it helps to isolate the high-velocity jet from the surrounding medium, and to guide the steam during its passage through the succeeding rows. For electrical work a vertical design was adopted on the ground of accessibility and floor space required, but when the footstep bearing and the auxiliaries in connection with it are taken into account the general opinion will be found in favor of the horizontal type. The tendency to leakage where the shaft passes through the diaphragms is greater than in the many-stage design, owing to the greater pressure difference in succeeding chambers; but as the bearing centers are small, a stiff enough shaft appears to be possible without necessitating so large a diameter as to give a large leakage area. A horizontal design has to be accepted for marine work, and possibly the experience gained in this line has influenced the builders of electrical sets, who now appear disposed to change over to the horizontal.

The Riedler-Stumpf turbine is another pure impulse type, in which the attempt was made to utilize a high-velocity jet by means of elaborate guide blades which collected the jet leaving the moving wheel blades, and redirected it on to the same wheel in another part of the circumference. A very high blade speed, in the region of 1,050 feet per second, was adopted with the nozzles arranged tangentially, so that a reversal through 180 deg. was obtained. Here, again, experience proved the impossibility of guiding a high-velocity jet through several reversals in the direction of flow, and keeping it compact, so that a multiple stage design with a lower velocity of jet had to be adopted to obtain a better steam consumption.

Other types of pure impulse turbines have been developed, but without reaching anything like the success or prospects of those mentioned.

Combination designs have been introduced embodying both pure impulse and reaction blades in different parts of the same turbine. It is probable that for electrical work at least, slightly better steam consumptions can be obtained with the single-flow Parsons design than with any pure impulse type, so that the introduction of impulse blading necessarily increases the steam consumption slightly. The only question is whether the advantages gained by its introduction will offset this increase. The advantages must be very pronounced, however, to carry weight, as in these days of low steam consumptions a fraction of a pound means a large increase in the coal bill. The Westinghouse Companies has produced designs embodying the impulse principle at the H. P. end, while retaining the Parsons blading for the L. P. end. With a blade speed of 360 feet per second and a nozzle with two rows of moving blades, about 25 per cent of the total energy in the steam will be absorbed. With a steam pressure of 150 pounds gage per square inch this will give a pressure of about 45 pounds gage at the first Parsons blade and an increase in volume of about two and a half times.

The introduction of the impulse blading makes partial admission possible, and so avoids the first limitation of the Parsons design, while the increased volume at the first Parsons blade permits of a greater diameter being used for the minimum drum diameter, and consequently stiffens up the spindle. In the early designs the spindle drum was made the same diameter right through, the first Parsons blade being on almost as large a diameter as the impulse blades. For 1,500 kilowatts and upward they were made double-flow to eliminate the balancing dummies for the Parsons blading. It was hoped that the increased steam consumptions necessarily incurred by this arrangement, through the increased leakage area and surface friction, would not be so great as to offset the operating advantages gained by the elimination of all dummy troubles. By retaining the larger diameter for the first Parsons blading and the introduction of the double-flow arrangement halving the blade height, the blade heights came so low that the tip clearance became a large percentage of the blade heights, and, in conjunction with the other losses incurred, pushed the steam consumptions up. The steam chambers for the nozzles were in the main cylinder casting, and owing to distortion of the part carrying the Parsons blading these machines did not prove so free from blading troubles as had been expected. In later designs the nozzle chambers are castings separated from the main cylinder and only connected at the flange, with external pipes for the high-pressure and high-temperature steam, which is thus isolated from the main casting carrying the Parsons blading. The first Parsons blade is on a much smaller diameter, and the intermediate part made single-flow, so that a longer blade can be used. This involves a dummy piston to balance the intermediate part, but the L. P. section is still kept double flow to avoid a large diameter dummy piston for that part. For large units the trouble is to get sufficient area for steam passage at the L. P. end without excessively long blades, so that the double-flow arrangement here has some advantages. Small units are made single flow

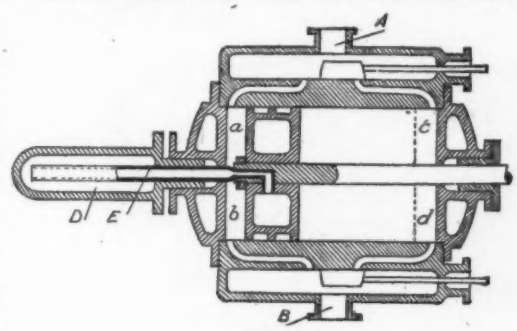


FIG. 1.

throughout, owing to the small volume of steam passing necessitating short Parsons blading. Similar designs have been produced on the Continent, while more recently a combination of Curtis elements at the H. P. end, with Rateau design for the L. P. end, has received a great deal of attention by several continental firms, especially for marine work.

In none of these attempts has it been unquestionably demonstrated that a steam consumption is obtainable which is quite equal to that possible with the Parsons design, and until that stage is reached the risks attached to the small clearances will continue to be accepted. Neither has any type been evolved that can extend the field of application by reason of a lower speed.

The mechanical advantages possessed by the pure impulse type will naturally continue to induce efforts being made to improve the steam consumption, but this must be obtained without introducing devices which will in any way detract from those advantages.

It has been conclusively demonstrated that the energy of a very high-velocity jet cannot be efficiently extracted at any blade speed which, owing to constructional and rotational limitations, can possibly be attained. Also that with many rows of moving and guide blades, or the elaborate guide blades returning the jet on to the same or succeeding wheels, the jet wastes a great deal of energy by spilling and setting up eddy currents in the surrounding medium.

Various devices have been tried to confine the jet when passing between the nozzle and the moving and guide blades, but this can only be done by the sacrifice of the "big clearance" advantage. Partial admis-

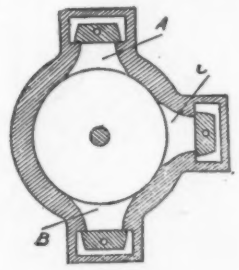


FIG. 2.

sion also adds to this loss, due to the moving blades being inactive for a part of each revolution. This loss will be highest at the H. P. end, owing to the greater inactive part of the circumference and the denser medium. At the L. P. end the whole circumference is active, so that a steady stream extends right round, which also tends to eliminate spilling and eddy currents.

Doubtless various combinations will continue to be tried in the hopes of improving the over-all efficiency, and owing to the many factors involved it is only by actual tests that this can be obtained.—The Engineer.

The total number of persons emigrating from Norway during 1908 was 9,597, of whom 8,600 were Norwegians, 846 Swedes, and 151 other nationalities. The majority of the emigrants went to the United States.

IMPROVING THE STEAM ENGINE.

EXPERIMENTS made by Karl Prinz zu Löwenstein, Baden, Germany, have shown that if the clearance space in the cylinder of a steam engine is made fairly large, and if water freed as much as possible from air is used for generating the steam, the back pressure under adiabatic compression does not increase, or increases only slightly. This condition renders possible the construction of a steam engine operated by steam which returns to the boiler in such a manner that the steam expanded in the working stroke of the piston is completely compressed by the return stroke.

If, in an ordinary engine, after expanding and doing work, the dead steam is compressed by the returning piston, it is the air in the steam, and not the compression of the latter, which tends to raise the back pressure during the return of the piston.

If cold water is used in the aforesaid experiment, or water which has merely been brought to boil, or even water which has been boiling for some time under low pressure and thus freed from air, and at the same time water is introduced to the boiler, as is commonly done by the ordinary feed pumps, very high back pressure is obtained when the dead steam is compressed. When boiled water is introduced the increase of the back pressure is much less than when using ordinary cold water, and finally when water is used which has been boiled for some time under pressure and is thus practically completely free from air there is hardly any increase of the back pressure.

According to an invention that Prinz Karl has patented, as a result of his investigations, a steam engine in which the expanded steam is returned to the boiler is worked with steam as free as possible from air, and the cylinder is kept substantially at the temperature which corresponds with the middle of the expansion, such as by surrounding it with a jacket through which a fluid of suitable cooling capacity is circulated.

In practice the clearance space of the steam cylinder is suitably proportioned; in Fig. 1, which is a longitudinal section through a steam cylinder, the clearance begins at the lines *a*, *b*, and *c*, *d*, respectively. The piston on its return compresses the dead steam up to the line *a*—*b*.

Before the end of the stroke superheated high pressure steam is admitted at *A*, and flowing through the clearance space returns to the boiler at *B*. The effect of the superheated steam is to vaporize the drops of liquid which, owing to the compression, have been deposited on the surface of the cylinder and piston, and carries this vapor together with the exhaust steam which has not been completely liquefied by the compression back to the boiler.

Shortly after the piston has attained the dead point the ports *A* and *B* are closed again and saturated steam is admitted through a third slide valve *C*, shown in the cross section Fig. 2, as in ordinary engines, or *B* alone is closed and the required charge is supplied by superheated steam admitted at *A*. By means of a fan or compressor the superheated steam is given a somewhat higher pressure than that in the boiler, so that on opening *A* and *B* it flows through the cylinder; or instead, liquid taken from the boiler is sprayed into a heated receiver in such quantities that the steam space contains unsaturated or superheated steam at a pressure somewhat higher than that in the boiler.

D is a vessel containing cooling fluid which is in communication with the interior of the piston through the pipe *E* and is for the purpose of preventing undue heating of the piston by the superheated steam. The cylinder cover also may be kept at a certain temperature by circulation of a cooling fluid.—The Practical Engineer.

LAYING CONCRETE UNDER WATER.

For the new Detroit River tunnel of the Michigan Central Railroad tremies are being employed to deposit the concrete under water. These tremies, operated from a barge carrying the concrete mixing plant, are riveted steel tubes, slightly longer than the deepest part of the river, and discharge the concrete directly into the forms. To exclude water while the first batch is being laid, two or three empty cement bags are stuffed into the top of the tube and wet concrete is poured in, forcing the bags down and the water ahead of them, and by continually maintaining the tube full of concrete no river water can enter.

After the concrete begins to emerge from the lower end, the tube is kept several inches under the surface of the mass, forming a seal. As the concrete builds up in the forms the tremie tubes are raised in the towers supporting them on the barge. A floater, consisting of a ball a foot in diameter and of slightly greater specific gravity than water, rises with the concrete and indicates through a wire to the operator on the scow when the tremie should be raised. The wet concrete distributes itself from the bottom of the tremie tube in a circle about 10 feet in diameter.—Iron Age.

OXHYDRIC PROCESS OF CUTTING METALS.—II.*

TORCHES AND MACHINES THAT CUT STEEL.

BY E. F. LAKE.

Continued from Supplement No. 1754, page 106.

In Fig. 6 will be seen a machine which is designed for accurate straight cuts either parallel with, or at right angles to the bed of the frame. The torch is mounted on a carriage which is moved longitudinally by hand wheels and a lead screw. Another hand wheel on the side of the carriage moves the torch away from or toward the machine, and as the oxygen nozzle should always follow the pre-heating nozzle, the torch may be

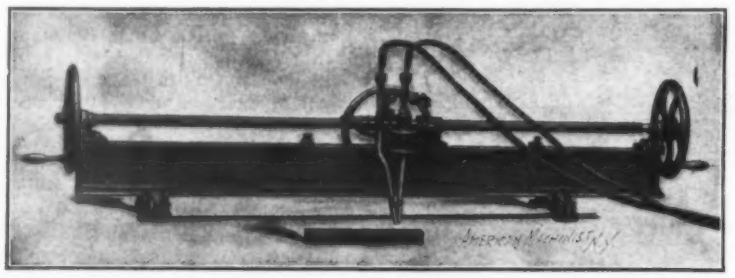


FIG. 6.—MACHINE FOR MOVING TORCH LONGITUDINALLY OR AT RIGHT ANGLE.

turned around by the small lever shown. The torch, as are all the torches, is provided with a valve for shutting off the gas. At the bottom of the machine is located a straight edge on which the nozzle slides. By means of an additional attachment that is not shown, the torch can be made to cut in a vertical direction.

In Fig. 7 are shown some samples of the work done with the above machine. The slabs themselves were first cut off with the oxhydric torch, and afterward the irregular cuts were made in the slabs. The narrowness of the cut, the square corners that it is possible to turn, and the fact that the metal is not burned on the sides of the cut are plainly seen.

The closeness with which the metal can be cut to a line is best illustrated by the small slab in the upper right-hand corner. In the center of the slab it will be noticed that there has been left a thin strip of metal. This is but ⅛ of an inch thick, while the cut is 1¼ inches deep, and is practically no wider at the bottom than at the top.

CUTTING REGULAR AND IRREGULAR CURVES.

In Fig. 8 is shown an appliance which can be used in an ordinary brace for cutting circles from 2 to 12 inches in diameter, and in Fig. 9 is shown the apparatus that can be attached to a beam located in a trammel point for cutting large circles. It will be noticed that the torch is fastened by thumb screws to two U-shaped rods that are mounted on wheels. Either of these rods, or both together, can be raised or lowered so as to accommodate the torch to any inequalities in the surface of the metal, or to locate it the proper height above the metal for successful cutting.

A machine for regular and irregular circular cutting is shown in Fig. 10. In this the hand wheel is used to turn the wheel, located on the trammel beam, by worm gearing, and thus give the torch a steady travel around the centering trammel point.

A slot is cut in the end of the beam so the operator can move the torch back and forth while he is moving the whole machine in a circle. The torch can also be revolved on 45 degrees of a circle so the heating nozzle can be kept in front of the oxygen nozzle.

In Fig. 11 is shown another machine for cutting regular or irregular curves together with some of the curves which have been cut. There is a small wheel located on a bar near the nozzle of the torch and this can be raised or lowered to locate the torch at its proper distance above the plate. The torch can be swung around so as to always keep the heating nozzle ahead of the oxygen nozzle. The apparatus is provided with an extra guide wheel, and an adjustable point which can be used where the guide wheel would interfere with the cut.

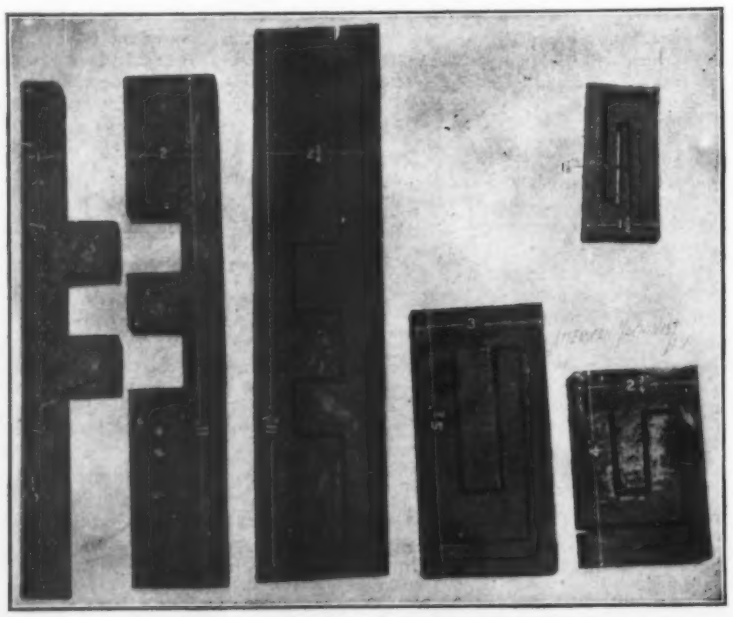


FIG. 7.—IRREGULAR SHAPED CUTS MADE WITH MACHINE IN FIG. 6.

CUTTING STEEL TUBES.

One of the most useful applications of this process is in the cutting of steel tubes or pipe. A special attachment has been made for this purpose, which is shown in Fig. 12. It is made in several sizes to accommodate the different sizes of pipe.

The pipe is inserted in the center of a ring and is

FIG. 8.—APPLIANCE FOR CUTTING CIRCLES WITH BRACE.

clamped there by three set screws. The torch is then revolved around the pipe and cuts it with a good clean cut and hardly any waste of metal. A small wheel, that runs around the pipe back of the nozzles, locates their position, and adjustment can be obtained by means of a spring inside of the apparatus. This apparatus is especially valuable in plants where power is not available. The cost of cutting pipe by this process can be obtained from Table 3, which gives the amount of gas consumed when cutting pipe from 2 to 12 inches in diameter and from 3/32 to 5/16 of an inch thick.

TABLE III.—AMOUNT OF GAS USED FOR CUTTING AND WELDING TUBES FROM 2 TO 12 INCHES DIAMETER.

Thickness of Metal.	Outside Diameter of Tubes in Inches.																	
3/32 to 1/8	2	2¼	2½	3¼	3¾	4¼	4¾	5¼	5¾	6¼	6¾	7¼	7¾	8¼	8¾	9½	10	10¾	12
1/4 to 3/8																			
7/16 to 5/8																			
	Cubic Feet of Gas Consumed.																		
Oxygen	2.3	2.6	3.2	4.5	5.2	5.9	6.6	7.4	8.1	8.8	9.5	14.4	15.3	16.3	17.3	18	19	21.5	24
Hydrogen	7.4	8.7	10.4	13.0	18.0	20.5	23.0	25.5	28 0	30.5	33.0	50.0	53.5	57.0	60.5	66	70	75.0	83

MANHOLE, RIVET-HEAD, AND PIPE-CUTTING MACHINES.

Another style of pipe-cutting machine is built, which

FIG. 9.—TRAMMEL POINT ON BEAM FOR CUTTING LARGE CIRCLES.

can be used on pipe that has flanges on both ends, and it is made so it can be adjusted to fit different diameters of pipe. This machine can be used for cutting the openings for branch connections. Branch flanges can also be cut out.

A manhole-cutting machine is also made which will cut oval, round, and square holes up to 8 inches square

* By courtesy of American Machinist.

or diameter. An elliptical segment which guides the cutting nozzle is applied to the cutting of oval holes in sizes from 2½ to 24 inches, and another corresponding segment is inserted into the machine for cutting round or square holes. This machine is very handy for boiler or machine shops, and a rivet head-cutting machine is built which is very handy for the boiler shop. (To be concluded.)

TO DETERMINE SIZE OF GAS AND OIL ENGINE CYLINDERS.

By NEWTON WRIGHT.

THE determination of the size of a gas engine cylinder from the heating value of the fuel, and the pressure caused by the theoretical rise of temperature, is impractical, as the losses due to incomplete combustion, cooling effect of jacket, and incomplete expansion, cannot be estimated with any great degree of accuracy. The size is most conveniently determined from the known fuel consumption of engines of similar power and type, provided the ratio of air to gas is also known. The formulas given in this article will aid in determining the size required, in this manner. In the formulas given the notation used is as follows:

d = diameter of cylinder in inches,
s = stroke in inches,
n = revolutions per minute,
H = brake horse-power per cylinder,
c = cubic feet of gas per brake horse-power hour,
w = pounds of oil per brake horse-power hour,
r = ratio of air to gas or vapor,
r_1 = ratio of air and products of combustion (in clearance space) to gas or vapor,
k = ratio of total capacity of cylinder to piston displacement,
V = piston displacement per stroke in cubic inches,
V_1 = piston displacement in cubic inches per brake horse-power,
v = clearance volume in cubic inches,
m = ratio of diameter to stroke.

One pound of heavy oil gives about 12 cubic feet of vapor, and one pound of light oil about 6 cubic feet; consequently, in applying the following formula for the ratio of air to gas or vapor, to oil engines, $12w$ and $6w$, respectively, are substituted for c. The value of the ratio r is expressed by the formula

$$r = \frac{d^2sn}{ck \times 72} - 1$$

The ratio r varies from 2 to 3.3 for producer gas, from 7 to 12 for lighting gas, from 27 to 40 for vapor of heavy oil, and from 36 to 52 for the vapor of light oil. With the most economical engines the value of r lies between the two figures given, but is generally nearer the lower than the higher. Perhaps the average figures would be with producer gas, 2.4; lighting gas, 9; heavy oil, 30; and light oil, 40. In the last two instances, this value of the ratio would make 360 cubic feet of air per pound of heavy oil, and 240 cubic feet of air per pound of light oil.

The value of the ratio of air and products of combustion (in clearance space) to gas or vapor is expressed by the formula:

$$r_1 = \frac{d^2snk}{cH \times 72} - 1$$

The ratio k of total capacity of cylinder to piston displacement is given in Table I.

Table I. Ratio of Total Cylinder Capacity to Piston Displacement.

Absolute Compression in Pounds per Square Inch.	k	Absolute Compression in Pounds per Square Inch.	k
30	2.65	75	1.46
45	1.86	90	1.38
60	1.58	105	1.33

The value of k is higher than it apparently would be, as the heating of the air following the compression causes the pressure to rise in a greater ratio than that due to the actual compression. When means are taken to clear the cylinder of the products of combustion, as is usual with engines working on producer gas, then r_1 will equal the ratio of pure air to gas.

The value of the piston displacement per stroke, in cubic inches, V, is expressed by the formula:

$$V = \frac{Hc\,(r+1)\,57.6}{n}$$

The relation between the diameter of the cylinder

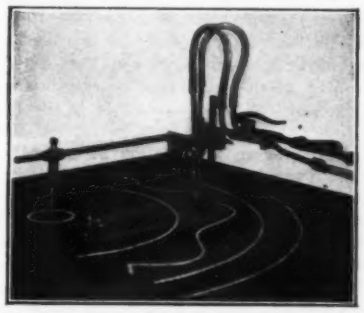


FIG. 11.—ANOTHER MACHINE CUTTING REGULAR AND IRREGULAR CURVES.

and the other quantities affecting it, is expressed by the formula:

$$d = 4.2\sqrt{m}\sqrt[3]{\frac{Hc\,r+1)}{n}}$$

The ratio of the diameter to the stroke m equals, of course, $\frac{d}{s}$, or $d = sm$. From the formula given it will be seen that if the length of stroke is given, the power of the engine will be proportional to the square of the diameter; but if the ratio of the diameter to the stroke is given, the power will be proportional to the cube of the diameter. Table II gives the usual values of m employed.

The clearance volume is determined by the formula,

$$v = V\,(k-1) = d^2s \times 0.7854\,(k-1).$$

The total volume of the cylinder equals $V + v = Vk$.

Table II. Common Values for Quantities Entering In Calculations of Size of Gas and Oil Engine Cylinders.

Fuel Used.	H	c or w	n	m	V_1
Producer gas.	20- 50	85	170	0.6	100
	50-100	80	160	0.7	100
	over 100	75	150	0.9	100
Lighting gas ...	to 5	30	300	0.5	60
	5-20	25	220	0.5	66
	20-50	20	170	0 6	70

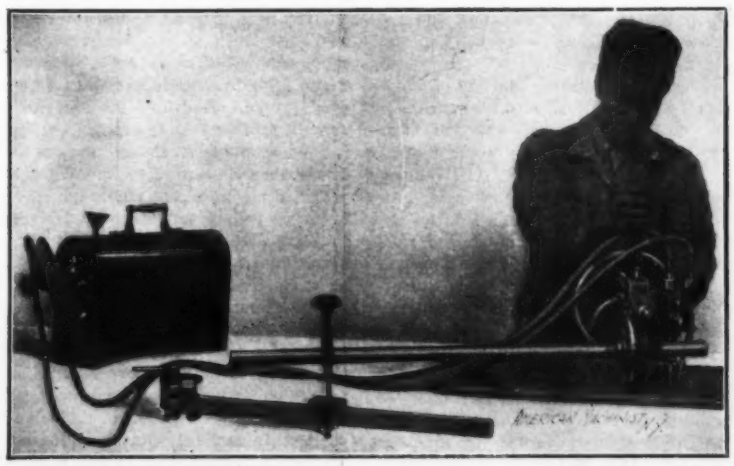


FIG. 10.—MACHINE FOR REGULAR OR IRREGULAR CIRCULAR CUTTING.

OXHYDRIC PROCESS OF CUTTING METALS.

Fuel Used.	H	w	n	m	V_1
Heavy oil	to 5	1.2	300	0 5	85
	5-20	0.9	220	0.5	88
	20-50	0.7	170	0.6	90
Light oil	to 1½	1.00	750	0.6	19
	5	0 75	750	0 8	14

The compression varies from 35 to 80 pounds per square inch, and is usually about 75 pounds. The piston speed in feet per minute is from 400 to 700 in gas and heavy oil engines of less than 200 horse-power per cylinder, up to 1,000 in the largest engines. In light oil engines the piston speed is seldom less than 650 feet per minute, even in the smallest sizes, and more in the larger.

Assuming a consumption of 80 cubic feet of producer gas per brake horse-power, 25 cubic feet of lighting gas, 0.9 pound of heavy oil and 0.75 pound of light oil, and taking the average values of r as given in the first part of this article, the following formula may be employed for finding the diameter of the cylinders, if the ratio between the diameter and the length of stroke is given.

$$d = f\sqrt[3]{m}\sqrt[3]{\frac{H}{n}} = \frac{f\sqrt[3]{m}}{\sqrt[3]{n}\sqrt[3]{H}}$$

In this formula f is a coefficient which equals 27.2 for producer gas, 26.4 for lighting gas, 29 for heavy oil, and 24 for light oil. At ordinary speed H would equal, approximately, $\frac{d^3}{5}$ for producer gas, $\frac{d^3}{4}$ for lighting gas, $\frac{d^3}{6}$ for heavy oil, and $\frac{d^3}{4}$ for light oil. These formulas, however, will not hold good for very small engines, say under 10 horse-power, except for those using light oil.

The heating value of the fuel is usually as follows: Producer gas, 150 B. T. U. per cubic foot; lighting gas, 660 B. T. U. per cubic foot; heavy oil (specific gravity about 0.88), 20,000 B. T. U. per pound; light oil (specific gravity about 0.69), 28,000 B. T. U. per pound.

As has been mentioned before, one pound of heavy oil gives 12 cubic feet of vapor, and one pound of light oil about 6 cubic feet, so that the heating value per cubic foot of vapor is 1,660 with heavy oil, and 4,660 with light oil.

Taking the average ratios of r as given before, the heating value of the mixture of air and gas drawn into the cylinder per cubic foot is, with producer gas 45, with lighting gas 66, with heavy oil 55, and with light oil 114. If the clearance space is allowed for, and assuming 75 pounds compression, the figures are 37, 48, 37, and 80, respectively. A theoretically perfect engine requires 2,545 B. T. U. per horse-power-hour, corresponding to a consumption of 17 cubic feet of producer gas, 3.9 cubic feet of lighting gas, 0.125 pound of heavy oil, 0.091 pound of light oil. If the efficiency of the gas producer is taken into account, minus 0.182 pound of anthracite or 0.212 pound of slack, as one pound of coal, the producer gives about 62 to 70 feet of gas.

The preceding formulas refer to ordinary 4-cycle single-acting engines. For engines with several cylinders, the power, fuel consumption, etc., should be taken for one cylinder alone, and if a double-acting cylinder, the power, fuel, etc., for one end.—Machinery.

The new steel process which is brought out in Europe and is to be controlled by Mr. Martin S. Kolman of New York has awakened considerable interest. Mr. Kolman is preparing to make a demonstration of the process, which converts finished iron into steel, before a body of representatives from the leading steel firms who are to be convoked for the purpose. A piece of iron can be given a coating of steel on the surface which can be as thin as an egg shell, or again can be of half an inch or an inch thickness according to the requirements. Using soft iron to make any kind of a shape, such as a razor blade, this can then be converted into very hard steel by the process, and it is claimed that such blades are equal to the best made. In this process the iron is simply treated with a chemical composition and is heated at the same time. The action of the composition serves to convert the iron into steel and gives it a temper at the same time, so that great hardness is the result.

FIG. 12.—END VIEW OF PIPE-CUTTING MACHINE.

ANCIENT MARBLES USED IN MODERN TIMES.*

THE SOURCES OF ANCIENT STONE SUPPLY.

BY MARY WINEARLS PORTER.

IT is a curious fact that many of the marbles employed by the Romans, Greeks, and even Egyptians, are those most highly valued by the architects and builders of the present time. Marbles and other decorative stones from the identical localities which were sought out by the ancients with so much care and patience, and used to such perfection in their sculpture and architecture, are now to be seen in most fine modern buildings in London and other cities. These ancient quarries, after having been lost to human knowledge for so many hundred years, have one by one been rediscovered within the last century and a half. In some cases these discoveries have been made accidentally by explorers or by engineers surveying for railways; but for the most part the quarries have been searched for and brought to light solely with an eye to their commercial value, and for the express purpose of putting again upon the market the materials so highly prized and extensively employed in former ages.

Marble was used in Egypt in predynastic periods, and the early Cretans had advanced so far in civilization as to make imitations and paint their cement dados to look like the genuine material so early as twelve hundred years before the Christian era. Sculptured slabs of marble have been found in Nineveh; but it is to the Greek that the real introduction of decorative marble is due. When

"Greece, conquered Greece, her conqueror subdued,
And clownish Latium with her arts imbued."

the Romans learned the use of marble, employing it far more lavishly than ever it had been used in Greece, and, alas! vying with the dishonest Cretans in their painted imitations, which survive to this day in Pompeii.

It is said that Quintus Metellus Macedonicus was the first to corrupt republican simplicity, introducing costly building materials into Rome about the year 144 B. C. When Cæsar reached Rome after crossing the Rubicon he found the treasury empty, and one of his most successful ways of replenishing it was to levy a tax on every column of imported marble. The great Cæsar himself was not free from the prevailing love of art and antiquities, and is said to have paid sixteen thousand pounds for two pictures!

It was not until the reign of Augustus, however, that the passion for marbles exceeded all bounds, and it was the boast of this emperor that he found Rome of "unbaked brick but left it of marble." The passionate desire to obtain marble for the ornamentation and decoration of temples, baths, forums, and private houses in the luxurious days of the Empire can hardly be exaggerated. The Roman baths were particularly ornate; and Seneca, in speaking of certain of them, says: "What noble statues! What vast pillars supporting nothing, but placed there for mere ornament and the vain ostentation of expense! What large and far-sounding cascades! What! are we arrived to such a pitch of delicacy and extravagance that we cannot tread but upon precious stones?" Parts of the above quotation might well refer to certain hotels, clubs, and other buildings of the present day. The emperors themselves, moved by an inordinate desire of obtaining marble through confiscation or purchase, took possession of all the most celebrated and valuable quarries. Suetonius relates how Tiberius stole quarries both from private individuals and cities. No wonder that the prices of private mansions reached fabulous sums. For example, the house of Claudius had cost one hundred and thirty-three thousand pounds, and that of Scaurus was valued at eight hundred and eighty-five thousand pounds; and these were prices during republican times!

At the present day nine thousand whole columns of marble have been enumerated by Prof. Lanciani in Rome, and he estimates the number of columns landed at Ostia in ancient times to have been four hundred and fifty thousand at least, and says there is no fear of exaggeration in this estimate, considering the amount of destruction, of breaking up, of burning into lime, that has been accomplished in Rome since the fall of the Empire, and columns represented but a small item in the marble trade of that city!

However, to return to the use of ancient marbles in England. It is a striking fact that in many gorgeously decorated hotels and clubs one sees in all directions, in the form of slabs and columns, marble of every color and hue, of which not a small part had its origin in the quarries worked by the Greeks and Romans in some cases as early as 500 B. C., as, for instance, those of the famous *marmor Pentelicum*. This marble, exceedingly fine grained and smooth, is even of a purer white than that of Carrara, and Pausanias alludes to its use many times. In one instance he states that its quarries were nearly exhausted in the construction of Herod's stadium. However, this is rather misleading, as even at the present time work in them is kept in full swing night and day, and about a thousand workmen are stated to be employed. Of greater interest is the fact that a few years ago half a million cubic feet of marble were supplied for the restoration of the same stadium, all from that wonderful Mount Pentelikon, where millions of tons yet wait to be quarried, and whence quantities of it are being shipped to England and to America. This marble has just been employed for an entire building in London, that of Mappin & Webb. Blocks weighing as much as twenty tons have been taken down to the port of Piræus and loaded on shipboard for export.

An interesting insight into the love and passion of the Romans for treasures of art and antiquity, relating to the above-named marble, may be found in the following quotation taken from one of Cicero's letters to Atticus: "As to your Hermæ of Pentelic marble with bronze heads, about which you wrote to me, I have fallen in love with them on the spot. So pray send both them and the statues, and anything else that may appear to you to suit the place you wot of, my passion, and your taste—as large a supply and as early as possible. Above all, anything you think appropriate to a gymnasium and terrace. I have such a passion for things of this sort that, while I expect assistance from you, I must expect something like rebuke from others. If Lentulus has no vessel there, put them on board any one you please." Pentelic marble was not used to any great extent in Rome, but was valued by the greatest of Greek sculptors. For instance, Scopas and Praxiteles used it, and the Parthenon may be given as the most famous example of its employment.

Another marble greatly admired by the ancients and in vogue at the present day in England is the *marmor Scyrium*, or variegated marble from the island of Scyros. "There are quarries of variegated marble called Scyrian; in appearance it resembles that marble which is described as variegated Lydian, a variegated stone," writes Eustatius to Dionisius Periegetes. Statius also mentions this marble, and Strabo said that columns and large slabs of it were to be seen in Rome, "with which the city is embellished, both at the public charge and the expense of individuals." This marble, which is known to the Italian stonecutter as *sette basi* (because it was first found in the ruins of the villa of Septimus Bassus), and also another variety which is called *semesanto*, were used to the greatest extent during the reign of Nero. The island of Scyros is honeycombed with the ancient Roman quarries, which are being reworked, and the marble is in great demand. The finest variety and the most valued in ancient times has a white ground stained profusely with a rich red, purple and yellow often appearing, the effect being most attractive.

A marble of great celebrity and quarried to an extent almost inconceivable by the ancients is the *marmor Carystium*, better known in modern times as *cipollino* (from *cipolla*, the Italian for onion, referring to its laminated structure, which resembles that of an onion), and used in considerable quantities in England. This marble, mentioned by Pliny, is supposed to have been the first colored marble brought to Rome, and came from Carystus, in the island of Eubœa, and according to Pliny it was employed in building the house of Mamurra, the date of which is said to have been 48 B. C. Many inscriptions have been found proving the early use of this marble, and from one of them of Hadrian's reign we learn that a new quarry had just been opened. The numbers on rough blocks found in Rome, beginning with two, mount up to two thousand four hundred, and Corsi in 1845 enumerated five hundred and eleven whole columns still preserved in Rome. This most ancient and unique marble has a white ground banded and zoned with a sage-green of almost every shade. Sometimes the bands are almost parallel, and again they are wavy and distorted and often dislocated. It is said that, because the marking of this marble resembles the waves of the sea, Agrippa in dedicating the temple to Neptune ornamented it with Carystian marble. The quarries, perhaps the largest of antiquity, were worked by the Greeks and later by the Romans, when they were, of course, imperial property, and have been rediscovered by Mr. Brindley after having been lost for nearly two thousand years. They are now being worked vigorously; and during the last few years, says Mr. Brindley, over one hundred monoliths of large size have been sent to England, America, and Germary, shafts for columns being obtainable of practically any size. Great quantities of *cipollino* were used in the decoration of St. Mark's at Venice, and *cipollino* of inferior quality is also found in Switzerland and Italy. Examples of both varieties are to be seen in Westminster Abbey.

A marble of beauty and note is the so-called Numidian marble, or *giallo antico* (antique yellow) of the Roman stonecutter of to-day, used so extensively of late years in England, but at the present moment not so much in fashion as some of the more recently imported marbles, which on this account are in vogue as presenting "something new," the beauty of the marble being merely a secondary consideration. This desire for the novel was likewise evident during the later days of the Republic and the early part of the Empire. It would seem that in many cases, then as now, the rarity and novelty of the object rather than its beauty was the attraction to the buyer. Pliny alludes to Numidia, the home of this justly famed marble, in northern Africa, as follows: "This country produces nothing remarkable except its marble and wild beasts." *Giallo antico*, so much beloved by the Romans, stands alone even to-day as the most beautiful of yellow marbles, so rich and deep are its colors, and so exquisite its compact texture, thus assuring a fine polish. Papinius Statius was indeed justified in saying "the yellow stones of Numidia are resplendent." This marble varies in color from the faintest straw-tint to deep shades of rich yellow, usually broken by a few thin veins of purple, brown, or yellow slightly darker than the ground mass. Besides these are the flesh-colored, called *giallo carnagione* (the flesh-tint is produced artificially by heat), and brecciated varieties. The last-named are of many shades of yellow, brecciated with golden brown, yellow, and white, and known as *giallo brecciato* (brecciated yellow). The most striking of the Numidian marbles is the *breccia sanguigna* (blood-colored breccia), also known as *rouge Etrusque*, a startling combination of reds and yellows of deep shades, brecciated and confused, producing a handsome but somewhat gaudy effect. Numidian marbles are to be seen in Westminster Abbey, also in the wall-panelings of the National Gallery in London, and in decorations in Brompton Oratory. The name Numidian is incorrect, as the localities where the Romans obtained the stone were in the ancient provinces of Mauritania and Africa, and not in Numidia, although near it. Most of the material employed in Rome came from Simittu Colonia, the modern Chemton, in Tunis, where the quarries are once more being worked; and Hadrian, on his first visit to Africa (about A. D. 128-29), constructed a road from them to Tebarca, where the stone was shipped to Rome. These stones were also found near Kleber, in the province of Oran, Algeria. Signor Boni tells me that he is led to believe, from pieces of *giallo antico* found in the sacrificial or expiatory stratification under the *niger lapis*, that this marble was brought to Rome as early as 200 B. C. Pliny, who (although he severely censured the use of marble) left us much valuable information concerning it, said: "M. Lepidus, who was consul with Q. Catullus, was the first to have the lintels of his house of Numidian marble, a thing for which he was greatly censured. He was consul in the year of Rome 676 (about 78 B. C.). This is the earliest instance I can find of the introduction of Numidian marble, not in the form of pillars . . but in blocks, and that, too, for the comparatively ignoble purpose of making the thresholds of doors." Hadrian ornamented his villas at Tivoli and Antium with Numidian, and gave twenty columns of it to the Gymnasium of Smyrna, the quarries of course being imperial property. Under Marcus Aurelius new quarries of these stones were opened, described by Paul the Silentiary as "those that the Libyan sun, pouring down his golden rays, tinges with hues of saffron and of gold."

The most curious and distinctive in appearance of all the ancient marbles used at the present time in America is the *lapis Atracius* of the Romans or *verde antico* (antique green) of to-day. Paul the Silentiary completes his description of this marble, which he studied in the mosque of St. Sophia, Constantinople,

* Chambers's Journal.

in the following words: "It exhibits, in short, a combination of beauties," which indeed is the case. This rock, outside of its historical interest, is particularly worthy of note from a geological point of view, and appears to be a breccia of white calcite, green talc, and serpentine. The ground mass is of every shade of green, and the fragments, which are mostly angular, are greenish black; and white calcite is conspicuous throughout the whole. The quarries are near Larissa, or ancient Atrax, in Thessaly; they were rediscovered some years ago by Mr. Brindley, who describes a square block he saw there containing over four thousand cubic feet, and are worked again for the first time since the reign of the Emperor Justinian (A. D. 483-565). This stone, employed alike by the Greeks and Romans, is used frequently in England, in spite of the fact that it is difficult to work and expensive. Magnificent columns of it are to be seen in Westminster Abbey, also examples in Brompton Oratory.

The most important of all the marbles of ancient times and of to-day is that of Carrara—the *marmor Lunense* of the Romans, quarried at the ancient city of Luni, sixteen miles from the modern Carrara. The quarries of Carrara, the most extensive and celebrated in the world, were described by Strabo, and have been worked from the beginning of the Christian era, if not earlier, and at the present time supply Europe and America—the greater portion going to the last-named country—with thousands of tons of material annually.

It is needless to describe the fame and beauty of the well-known Carrara marbles, seen at every turn, the supply of which appears to be inexhaustible. From the quarries, called by Statius "quarries of snow," came the marble so closely associated with the names of the great Augustus, of Michelangelo, of John of Bologna, Vasari, and Canova. Among other ancient marbles used in England are the *marmor Celticum*, or black-and-white marble of France (St. Anne's), quarried by the Romans, and rediscovered in 1844 near the river Lez, in southern France; the *marmor alabastrum*, or Algerian onyx marble; the *marmor Tœnarium*, or *rosso antico*, from the province of Mani in Greece, to be seen in Brompton Oratory and Westminster Abbey; and, finally, the green serpentine of Tinos.

It seems interesting that we deem it necessary, as did the Romans, to go beyond the seas in search of materials with which to enrich our homes and public buildings, "in order that as much as possible may be lost whenever a conflagration happens," says Pliny, who railed against the excessive use of marble in his day.

KIESELGUR OR INFUSORIAL EARTH.

ITS MANY VARIED USES.

BY O. BECHSTEIN.

FEW of the materials which Nature offers to man have found more extensive and varied applications than kieselgur, or infusorial earth, which is used in larger or smaller quantities in steam boilers and engines, refrigerating machinery, various chemical manufactures, pharmacy, building, the manufacture of matches, that of fertilizers, and in numerous other industries.

Kieselgur occurs either as a dry loose powder or as a wet tenacious mass resembling chalk or clay, of white, yellow, light gray, red, or brown color. It is composed chiefly of the empty silicious shells of diatoms, a class of algæ and has nothing to do with infusoria. The organic constituents have decayed and only the shells remain. Diatoms, which live both in salt and in fresh water, and of which more than 20,000 species are known, are unicellular organisms inclosed in envelopes consisting chiefly of silica. The largest German deposit of kieselgur, in the Lueneburg Moor, consists chiefly of the fresh-water forms *Cymbella*, *Navicula*, *Melosira*, *Synedra*, and *Gomphonema*, which under the microscope appear as delicate and very beautiful objects of great variety. Their diameters vary from 0.0003 to 0.006 inch, so that a cubic inch of kieselgur contains many millions of diatom shells. The specific gravity of kieselgur is about 0.24. Its proportion of silica varies from 80 to 90 per cent. It contains also, 6 to 12 per cent of water, 2 to 4 per cent of organic matter, 1.5 to 2.5 per cent of ferrous oxide, about the same proportions of clay, 1 to 1.5 per cent of lime, and a small amount of magnesia. The structure of kieselgur, which consists of countless silicious shells filled with air, determines many of its valuable properties, such as its power of absorbing five times its weight of water, its low specific gravity, and its low conductivity for heat and sound. Its great resistance to fire and acids, after incineration, and its high percentage of silica make it suitable for various other applications.

Kieselgur is found in places which were formerly covered with water. Large deposits occur in the North German plains, in the Lueneburg Moor where the beds are 30 feet in thickness, near Kassel, in the Vogelsgebirge, and beneath the city of Berlin. Many other countries contain similar deposits of marine or fresh water origin. The loose variety of kieselgur, which is used for industrial purposes, is always of fresh-water formation.

Kieselgur is mined mostly from open pits, being dug, or in some cases blasted out, and sent to market either in the crude state, or after being broken up, calcined, and for some uses, ground fine.

The industrial application of kieselgur in Germany commenced about 1865. The ancient Romans and Greeks, however, appear to have made artificial stone of infusorial earth, for Strabo speaks of tiles which floated on water, and the Byzantine emperor Justinian is said to have ordered the use of stone made of infusorial earth in the construction of the dome of the basilica of St. Sophia in Constantinople.

At first, in Germany, kieselgur was used solely as a heat insulator, for covering steam pipes, cylinders, boilers, etc. For this purpose it is especially well adapted, as it is very light, easily applied by mixing with water to form a paste, and very durable. It is also comparatively cheap, entirely unaffected by the highest temperature to which it is likely to be exposed, and, especially, a very poor conductor of heat. There are a few better heat insulators, but they are more expensive and more affected by high temperatures, so that kieselgur remains practically the best, as it is the most widely used, material for this purpose. The prevention of heat losses has acquired immense importance in connection with the modern tendency to economize fuel.

Kieselgur is also used as a heat insulator between the double walls of fireproof safes and chests, ovens, drying rooms and kilns, and for the protection of freight and passenger compartments in steamships from the heat of the engines and boilers. In the refrigerating industry also advantage is taken of the low thermal conductivity of kieselgur, which is used around ice machines, refrigerating pipes, ice cellars, cold-storage rooms, refrigerator cars, ice boxes, etc. For storerooms in which food and other perishable articles are kept, kieselgur is greatly superior to sawdust, cork chips, bran, peat, and other organic substances, because it is not affected by dampness and it can be perfectly sterilized by roasting. Organic filling materials soon accumulate bacteria and fungi, which find their way into the interior of the compartments and spoil their contents.

Soon after the introduction of kieselgur as a heat insulator, it found another employment in the manufacture of dynamite. This application is said to be due to chance. In 1860 Alfred Nobel discovered in nitroglycerin a very powerful explosive, which however, being liquid, was difficult and dangerous to handle. It was transported in tin cans, which were packed in kieselgur to protect them from shock. According to the story, one of the cans leaked, the nitro-glycerin escaped and was absorbed by the surrounding kieselgur, and thus Nobel discovered the great absorbent power of kieselgur for nitro-glycerin. He had already attempted, but without success, to bring nitro-glycerin into a solid state by mixing it with gunpowder, charcoal, paper, and other porous substances. With kieselgur, nitro-glycerin forms a pasty mass that can be formed into cartridges which are easily handled and not very sensitive to shock. This mixture appeared in the markets in 1867 under the name of dynamite. Although many other substances are now used for this purpose, especially substances of an explosive nature, large quantities of kieselgur are still used in the manufacture of explosives.

The absorbent power of kieselgur is used in chemical industries in connection with the transportation of acids and other corrosive liquids. When carboys of acid were packed in hay, straw, or sawdust, the breaking of a carboy often ignited the packing. The mineral kieselgur is free from this danger, and it is so absorbent that it prevents the escaping acid from coming in contact with wooden boxes or other inflammable material. For similar reasons, kieselgur is largely used in the manufacture of fertilizers, and in agriculture for the absorption and preservation of liquid manures. Kieselgur is further used in the manufacture of ultramarine and water glass, because of its high percentage of silica, which is an important ingredient of these products.

The porosity of kieselgur makes it useful in filtering water and other liquids, including syrups, fruit juices, spirits, dyes, oils, and greasy liquids. Impure oils and fats are mixed with kieselgur and pressed. The oil flows clear from the press, leaving the impurities behind in the oil cake. For the purpose of filtering water, the aseptic character of calcined kieselgur makes it peculiarly appropriate.

In several branches of industry kieselgur is used as a filter on account of its lightness. The heads of Swedish matches contain a large proportion of kieselgur, which diminishes their density and makes them less liable to fall from the burning match. Added to sealing wax, kieselgur prevents too rapid dropping, without affecting the color or greatly increasing the weight. It is used also as a filler in many articles of India rubber and gutta percha, in which lightness is greatly desired.

Kieselgur is extensively used in pottery for making cheap glazes, which are free from fine cracks or hair lines, and in the manufacture of porous vessels which are proof against fire and acids. The sound-insulating properties of kieselgur cause it to be employed largely in building, the space between the ceiling of one room and the floor of the room above being partly filled with it. For special purposes, partitions are made double and filled with kieselgur. Telephone cabinets, for example, are so constructed. In other cases, plates made of kieselgur are applied to the walls and ceiling. In many of these cases, the heat-insulating property of kieselgur is an additional merit, keeping the rooms warm in winter and cool in summer. In many Russian cities, kieselgur is largely used as a filler in floors, where it possesses the further merits of being little affected by dampness, of preventing decay of wood, especially the dreaded dry rot, and of not harboring mice, rats, or vermin.

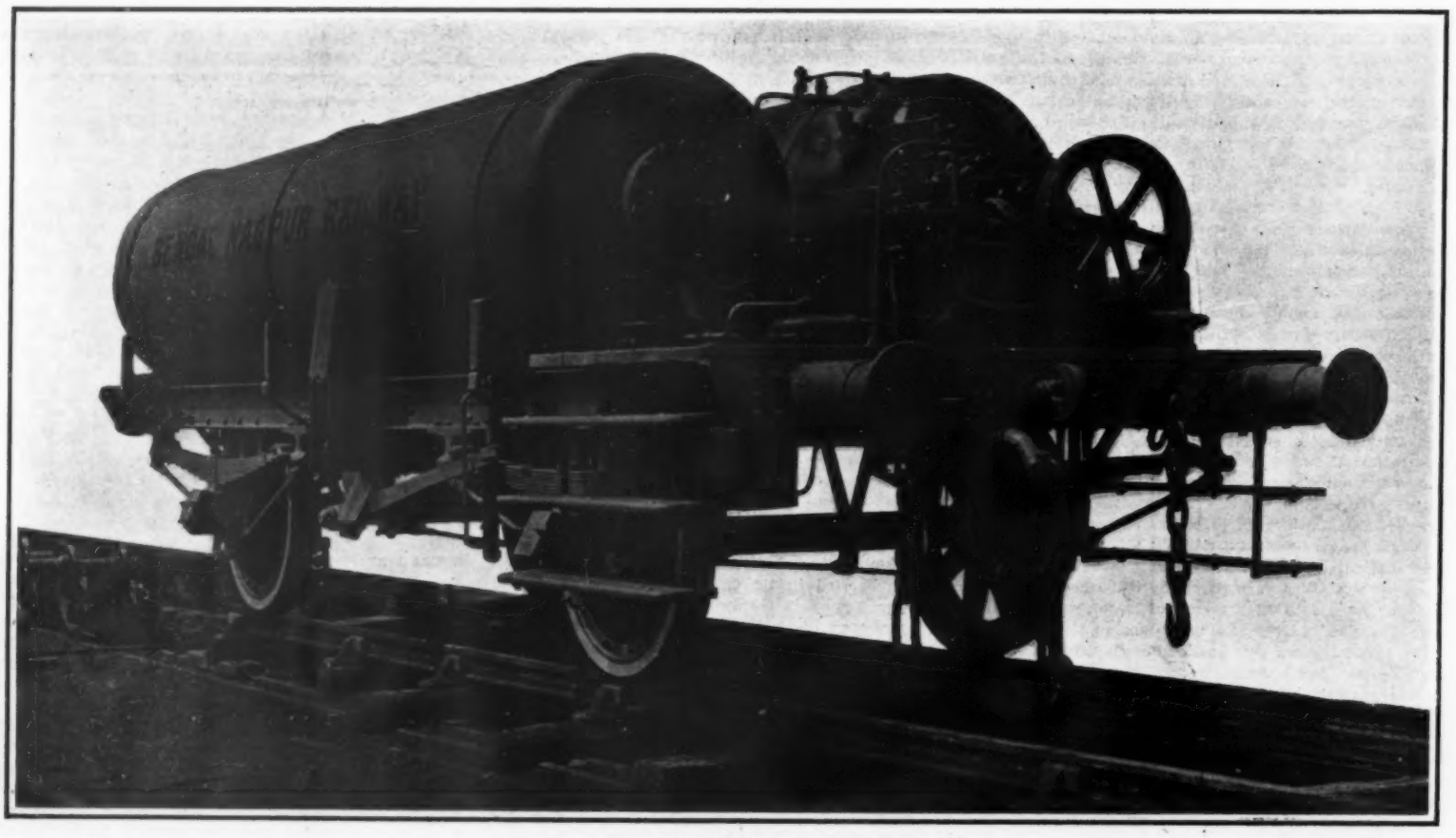
For walls which are required to be thin and yet to give good protection against heat and sound, kieselgur bricks may be used. These are made either of a mixture of kieselgur and clay or almost entirely of kieselgur with some suitable binder. Light wood and stucco roofs, which are used particularly in the tropics, are made by covering a light wooden shell with a kieselgur paste to a depth of about one inch. The kieselgur quickly hardens in the air and forms a seamless, watertight, durable, and very light roof. In all these applications in building, the fire-resisting properties of kieselgur constitute an additional advantage. A fireproofing paint or wood is made by mixing kieselgur with asbestos, water glass, glue, and water. Three or four coats of this paint give efficient protection against fire. It is employed also for checking the spread of dry rot, the infected parts of the wood being covered with several coats of kieselgur paint, which hardens into a stony covering and prevents any further extension of the fungus.

In conclusion, we may mention a few applications of kieselgur which illustrate the wide range of its uses, although they do not themselves consume very large quantities. Pharmacy employs carefully washed and calcined and very pure kieselgur, under the name of *terra silicea calcinata*, in the manufacture of dusting powders which possess great powers of absorbing water and grease and are entirely free from organic matter. The so-called disinfecting candles are sticks of kieselgur saturated with carbolic acid and other liquid and volatile disinfectants, which evaporate very slowly, so that the candles retain their disinfecting power for months. Wicks for alcohol and petroleum incandescent lamps are also made of kieselgur. Fire lighters are pieces of kieselgur saturated with petroleum, benzine, or other liquid fuel. These afford a certain and convenient means of kindling coal fires. They are not injured by the heat of the fire, and may be saturated again with oil and used indefinitely. Other applications of kieselgur are: in the manufacture of abrasive soaps and floating soaps, as a fine polishing powder for metals, in tooth powders and tooth pastes, in powders for the removal of grease from glassware, as a filler for paper, *papier maché*, gilt moldings, and other applied decorations, etc. The foregoing list, which is probably not complete, proves that this comparatively little known and little regarded substance has an extraordinarily great variety of uses.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

A NOVEL TRAVELING RAILROAD GAS-HOLDER.

AN INDIAN GAS SUPPLY CAR.

THE Bengal-Nagpur Railroad has recently introduced some new freight vehicles which should prove serviceable for the work for which they have been specially designed by Sir John Wolfe Barry, Bart., K. C. B. These are traveling gas-holders. The general outlines are displayed in the accompanying illustration. Four of these vehicles have been turned out from the Motherwell works of Messrs. Hurst, Nelson & Co., and are now in operation. The vehicle comprises a flat deck car having a length of 24 feet over head stocks and a wheel base of 14 feet, upon which is mounted two solid welded gas-holders, each 19 feet 3 inches in length by 4 feet 2 inches in diameter. On the platform at one end is fixed a 2-brake-horse-power gas-engine and compressor with antipulsator. Beneath the deck frame is slung a 50-gallon water tank. The other fittings comprise an adjustable regulator, Bourdon pressure gages, etc. By means of the compressor the gas can be pumped from one store holder to the other, or from the traveling tanks into the stationary store holder. The maximum working pressure of the tanks is 150 pounds per square inch. The tare of the vehicle complete is 11 tons 13 hundredweight. The car is designed for service upon a railroad gage of 5 feet 6 inches.



THE GAS CAR OF AN INDIAN RAILWAY.

RECUPERATION OF BENZINE.

THE health of persons engaged in the manufacture of India rubber cloth is injured by the vapor of the benzine employed as a solvent. Hence it is desirable, on hygienic as well as on economical grounds, to recondense and recuperate the benzine. In the Bataille waterproofing apparatus the cloth is exposed during treatment to a small mass of air, which becomes saturated with benzine vapor at a high temperature, and the greater part of the vapor is condensed when the temperature of this air is lowered. The apparatus is composed of light metal covers placed on the coating tables and entirely closed, with the exception of necessary slits through which the cloth enters and leaves the apparatus. These openings are provided with ingenious devices by which the inflow and outflow of air are made as small as possible. For the purpose of observation and manipulation the covers are provided with other openings, closed by removable stoppers. Beneath these covers circulates a small and unchanged mass of hot air, saturated with benzine. This air is subsequently drawn off and caused, by cooling and otherwise, to deposit most of its benzine. The same air, with its residual benzine, is again heated and passed over the operating tables, where it again becomes saturated with benzine, and the cycle is repeated indefinitely. It is claimed that 68 per cent of the benzine employed has been recuperated with the Bataille apparatus, the velocity of the cloth being such that drying was effected in 30 seconds, and cold water being the only refrigerant employed. The recuperated benzine is fit for immediate use and the net cost of recuperation is only 1/30 cent per pound. The apparatus is simple and occupies little room. It may be employed, with suitable modifications, wherever it is desired to suppress the vapor of benzine.

RESULTS OF TESTS ON SEVERAL GRADES OF FUEL IN A PRODUCER-GAS POWER PLANT.*

THE accompanying table shows the results obtained on a wide range of fuels tested by the technologic branch of the United States Geological Survey, under the direction of Joseph A. Holmes, expert in charge, and Robert Haywood Fernald, engineer in charge. These tests were made at St. Louis, Mo., at the fuel testing plant which was located on the grounds of the Louisiana Purchase Exposition.

At the time this plant was erected there were but few gas producer plants in the country burning any class of bituminous coals and many prominent engineers were in doubt as to the possibility of operating a gas engine on gas produced from coals such as are mined in the central and western States.

This branch has done a valuable service to the country in demonstrating the possibility of burning nearly all classes of low-grade fuels with good economy. As will be noted in the table the poorer coals required a correspondingly greater quantity of the fuel to produce a horse-power.

The equipment used was a 250 horse-power pressure producer with a centrifugal tar extractor and gas holder. A 235 horse-power three-cylinder vertical gas engine belted to a generator produced power which was measured by electric instruments connected with the switchboard. As will be seen, the results obtained are much better than those from steam plants of corresponding size.

Fresh discoveries of asbestos have been made upon the property of the South Urals Asbestos Company in the Orsk district. The average content in asbestos of one deposit is 15 per cent. At times it reaches as high as 80 per cent, in point of quality resembling chrysolite, and being very soft and wooly. The fiber is strong, while the color in lumps is olive green, but the single staple appears to be pure white. A second deposit presents similar conditions and wealth of content.

* Published by permission of the Director of the United States Geological Survey.

TABLE OF DATA AND RESULTS ON REPRESENTATIVE FUELS BURNED IN A PRODUCER-GAS PLANT AT THE FUEL TESTING PLANT OF THE TECHNOLOGIC BRANCH, U. S. GEOLOGICAL SURVEY.

Fuel.	Proximate Analysis, Per Cent.				B. T. U. per Pound of Fuel.		Cu. Ft. Standard Gas Produced per Pound of Equivalent* Fuel Consumed by Producer Plant.		B. T. U. per Cubic Foot of Standard Gas.	Pounds of Equivalent* Fuel per B. H. P. Hour.	
	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	As Fired.	Dry.	As Fired.	Dry.		As Fired.	Dry.
Florida peat.....	21.00	51.72	22.11	5.17	8.127	10.290	28 5	36 1	175 2	2.57	2.03
Average of four lignites	35.5	28.96	27 72	8.27	7 164	11 098	26.3	40.3	169.9	2.43	1.73
Average of four Illinois coals...	11.51	31 81	43.46	13.22	10.651	12 030	49.6	56.1	153.2	1.66	1.47
Average of four Pennsylvania coals.....	3.47	19 68	67.31	9 54	13 651	14.136	71 4	74 0	141 6	1.16	1.12
Average of four West Virginia coals.....	2.47	32 12	60 24	5 17	14.248	14.610	77.5	79.5	149.6	1 08	1.00

* Equivalent fuel includes that used in producer, and also the amount required to generate the steam necessary for operating the producer.
Of the four Pennsylvania coals tested, two came from the lower Kittanning bed, one from the lower Freeport and the fourth from the Pittsburg bed.
Of the West Virginia coals, one came from the Ansted bed, another from the Eagle, both of these being mined in the New River district, a third from the Pittsburg and the fourth from the Keystone bed.

THE AERONAUTIC EXPOSITION IN FRANKFORT.

A REMARKABLE UNDERTAKING.

THE opening of the international aeronautic exhibition on July 10th took place under the most unfavorable climatic conditions that it is possible to imagine; but in spite of this the influx of visitors from all parts of the world was very considerable.

It would seem that the idea of flying and floating through the air has so completely taken possession of the train of thought of all classes at the present time that difficulties which would be disastrous to the success of any other sort of exhibition, have here been readily overcome.

The people have been waiting eagerly for the arrival of the Parseval non-rigid motor-balloon from Bitterfeld, near Berlin; but at first the rain prevented Major Parseval from making a start. After the rain had cleared, hopes ran high again, but then a contrary wind blew continuously from the southwest, so that at last Major Parseval reluctantly decided to dismantle his airship and send it by rail. The contention of the partisans of the non-rigid system is that it is superior for military purposes to the rigid system on account of this transportability. We must confess that we prefer the rigid system of Zeppelin, which can get along in spite of the wind without any exterior aids. We have seen a letter from Zeppelin, in which he stated that he would probably arrive at Frankfort on August 1st from Friedrichshafen with the "Zeppelin" *en route* for Cologne, where the balloon is to be stationed by the government, and that he would remain in Frankfort for a couple of days.

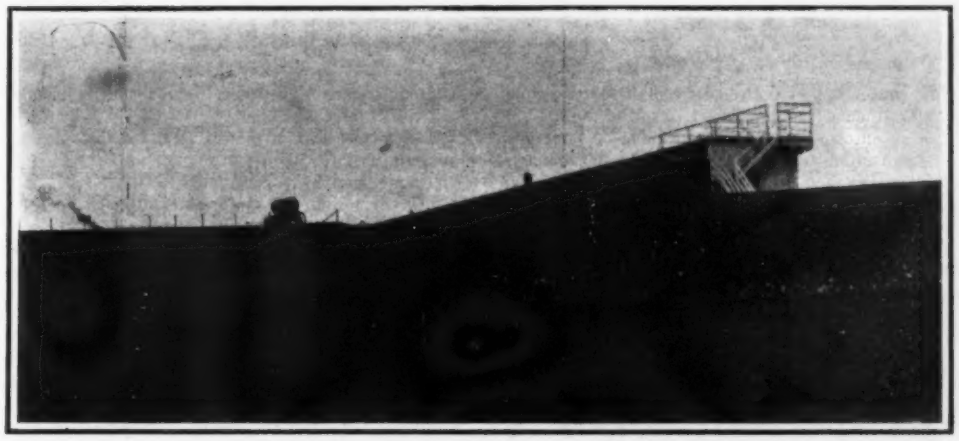
The shed which is being built for the "Zeppelin III." (which is in course of construction and is to be stationed at Frankfort during the whole time of the exhibition) cannot possibly be ready by the 1st of August, so that the "Zeppelin III." will have to camp in the open air. The shed is constructed of wood and will be covered with canvas.

The sheds shown in the photograph are of similar construction. That on the left contains the captive kite balloon constructed on the Parseval-Siegfeld system by the Riedinger Company. The next shed in order is intended for the dirigible of Fr. Clouth, Cologne, a semi-rigid one, which will be here in a few days. The balloon was never tried before and Mr. Clouth, Jr., will make the first ascent here. The capacity of the balloon is 1,700 cubic meters (60,034 cubic feet), about nine-tenths of the Zeppelin balloon. The balloon is 42 meters long and has a diameter of 8 meters (26¼ feet). The car is made of steel tubing and has a capacity of four persons. There are two wooden propellers—one on the right and one on the left between the car and the balloon. Both propellers make from 600 to 700 revolutions a minute and are driven by a 40-horse-power gasoline motor.

The next shed is intended for the mushroom balloon of Gans-Rodeck, which is not yet finished. The last shed is for the Parseval motor balloon. A description of all the balloons mentioned above will be given after their arrival in Frankfort.

The flying grounds and aeroplanes and gliders are somewhat removed from the exhibition grounds but are connected therewith by a small model railway. One photograph shows the arrangement of the take-off hill for gliders. It faces in one direction only, not being a circular hill, so that gliding can only be indulged in when the wind comes from the southwest.

The three other photographs show the exterior and the interior of the exhibition hall, a building thoroughly in keeping with the purpose for which it is used.



ARTIFICIAL INCLINE FOR GLIDING EXPERIMENTS.

The exhibits which have been brought together give a very fair view of the present state of aeronautics. The models of flying machines are very numerous; it would mean, however, that a lot of them were built in order to show how not to fly, but even these are instructive and interesting, as they show great mechanical ingenuity in their construction.

There is at the entrance a full sized machine shaped like a bird—body, beak, and all. The extremities of the wings are fitted with pivoted blades to represent feathers, but of course no one, as far as we know, has ever been mad enough to fly it. There are many freaks of this sort.

In the photographs some real flying machines, as well as gliders, are shown. A Farman and a Wright machine are exhibited. One of the original gliders used by Lilienthal has been lent by the Munich museum. It is a bird-like structure and shows signs of considerable wear and tear.

The middle of the hall is filled with the balloon "Preussen," which holds the record for height, 10,800 meters (35,439 feet). The capacity is 8,400 cubic meters (296,638 cubic feet), with a diameter of 25

ANOTHER GLIMPSE OF THE FRANKFORT AERONAUTIC EXPOSITION, SHOWING THE POWER EXHIBITS.

THE AERONAUTIC EXHIBITION IN FRANKFORT.

meters (82 feet). The ripping panel is 16 meters (52½ feet) long. The weight of the balloon alone is 955 kilogrammes (2,083 pounds), netting 740 kilogrammes (1,631 pounds). The balloon completely equipped and filled with hydrogen has a lifting power of 6,000 kilogrammes (13,228 pounds) and would be able to carry 80 persons.

Several high-angle guns are exhibited by Krupp and the Rheinische Metallwaarenfabrik, of which we give a photograph. The means for bringing down balloons show that the military authorities are fully alive to the important rôle which will probably be played in modern warfare by airships.

We shall deal with aeroplane and dirigible motors in our next article.

THE ATOMIC HYPOTHESIS.

THE EXPERIMENTAL EVIDENCE IN ITS SUPPORT.

BY R. EHRENFELD.

THE conception of matter as composed of ultimate particles, themselves undivided, was in the first instance an outcome of the natural mode of working of the human mind. But the advances of modern science have disclosed facts which go far to elevate the atomic theory from its primarily hypothetical character, and establish it upon a sound basis of fact.

Among the phenomena which have contributed to this development, we may mention first of all the optical properties of solutions. The fundamental criterion of a typical solution (of a crystalloid) is its homogeneous character. But homogeneity is after all only a relative term, for the apparent uniformity depends on the smallness of the dissolved molecules, and on the limitations of our means of observation. A ray of light which passes through a heterogeneous medium suffers diffuse reflection and polarization at the numerous surfaces of discontinuity within the medium. This gives rise to the phenomenon known after its discoverer as the Tyndall effect. The latter is so sensitive a test for the presence of discontinuities in the medium, that it required much special experimenting before the means were found for preparing an "optically clear" solution. To W. Springs is mainly due the knowledge of the only successful method, which consists in throwing down the fine suspended particles (dust) by means of gelatinous precipitates (hydroxide of iron, aluminium, or zinc) produced in the solution by suitable means. Solutions of cane-sugar, raffinose, and phosphomolybdic acid, however, can not be obtained optically clear by any manner of means. In these cases the size of the dissolved molecules themselves is the cause of the polarization of the transmitted light. The Tyndall phenomenon, as it were, enables us to see the molecules, clearly demonstrating the truth of the statement made above, that homogeneity is relative, and that the apparent uniformity of a medium depends on the smallness of the molecules.

True crystalloid solutions grade over without any sharp line of demarkation into colloidal solutions. The principal characteristic of these latter is their optical heterogeneity, although when viewed directly with the naked eye they appear perfectly homogeneous. Among colloids which form such "solutions" are certain organic compounds of high molecular complexity, such as albumen, and also some inorganic substances. Thus neutral solutions of salts of aluminium, chromium, iron, copper, mercury and lead show the Tyndall effect, owing to the presence of the colloidal hydroxide as a result of hydrolysis. On addition of a little acid this hydrolysis is prevented, and simultaneously the Tyndall effect is destroyed.

While the Tyndall effect clearly demonstrates the heterogeneous character of colloidal solutions, it is not very well adapted for the further study of the phenomena involved. This only became possible through the invention (1903) by Siedentopf and Zsigmondy of their method for rendering visible particles of ultramicroscopic dimension. This method, as is now well known, consists in viewing the particles to be examined under intense lateral illumination. A portion of the light incident upon a particle is reflected upward into the microscope, protruding a diffraction pattern against a dark background, since no light enters the microscope directly. In this way Siedentopf rendered accessible to view particles down to $5\,\mu\mu$ in diameter ($1\,\mu\mu = 1 \times 10^{-6}$ millimeter). In some cases the Tyndall test still shows a beam, when the ultramicroscope no longer discloses the presence of definite particles. Even in such cases it has sometimes been found possible to make an estimate of the size of the particles present. Thus on adding such a colloidal gold solution to a suitable reducing mixture (gold chloride and formaldehyde), the particles of the colloidal solution are found to act as "germs" around which clusters the reduced gold. In this way it has been possible to estimate the number and hence the size of these particles which even the ultramicroscope fails to disclose directly, amicrons as Siedentopf calls them, in contradistinction to the submicrons visible under his instrument.

The linear dimension of the amicrons has thus been estimated at 1.7 to 3 $\mu\mu$. Now such particles approach close to molecular dimensions, as is shown by the following table:

1. Mean distance between neighboring molecules in a gas, 3—4 $\mu\mu$.
2. Least thickness of metal which exhibits an electromotive force upon platinum, 1—3 $\mu\mu$.
3. Diameter of hydrogen molecule, 0.11—0.14 $\mu\mu$.
4 Lower limit of gas molecules, 0.02 $\mu\mu$.

In general molecular dimensions, as calculated from surface tension effects, range from 6×10^{-9} to 6×10^{-7} centimeter, while the limit of the ultramicroscope is about 5×10^{-7}.

The gradual transition from colloidal to true solution, of which mention was made above, is well brought out by the study of the sodium salts of the fatty acids. The higher members of the series, stearic, palmitic and oleic acids, give sodium salts whose aqueous solutions have all the characteristics of the colloid. The sodium salts of the lower acids on the other hand form true solutions. The sodium salts of nonylic and laurinic acid (containing respectively nine and twelve carbon atoms) are intermediate in character. Particularly interesting are a series of gold solutions prepared by Zsigmondy, in which the particles ranged from 130 $\mu\mu$ to 6 $\mu\mu$ and less. These represent all the gradations from a colloidal solution containing no particles within the resolving power of the ultramicroscope to the coarser solutions (from 60 $\mu\mu$ up), which as a rule are unstable, depositing a flocculent precipitate on standing.

Such experimental evidence points to the existence of every gradation in the size of the particles of which matter is composed, presumably down to molecular dimensions. The discontinuous, molecular, structure of matter is thus rendered highly probable.

There is another most interesting phenomenon displayed by colloidal solutions, which is highly significant from this point of view, namely, the so-called Brownian movement. When a colloidal gold solution is viewed by means of the ultramicroscope, the particles of gold are seen to move about briskly in a perpetual dance. The same thing is observed in mist, smoke, or dust suspended in a gas. There is little doubt that this motion is due to the impacts of molecules of the liquid or gas upon the suspended particles.

This, perhaps, will require a little explanation. According to the kinetic theory the molecules of a liquid or gas are not at rest, but move about with velocities depending upon the temperature. Their energy of motion constitutes the heat of the substance. Now if a body of ordinary dimensions is placed in such a liquid or gas, it will receive at any given time very nearly the same number of impacts in all directions, and will therefore remain stationary. But if the body is sufficiently small, the total number of impacts received in a short interval of time will not be sufficiently large to allow them to neutralize. The net effect will be to cause the particle to move now in this direction, now in that.

The theory of the Brownian movement has been worked out in some detail by Einstein and others, and experimental measurements made by Svedberg and Perrin show good agreement with theory.

But according to modern views the ultimate subdivision of matter does not end at molecules and atoms. Under certain conditions an atom of a gas may split if an ion or electron carrying a charge of negative electricity. These ions behave in certain respects like discrete particles, and upon this fact is based J. J. Thomson's ingenious method of determining the absolute charge of an ion. If ions carrying a known total charge are mixed with air saturated with water vapor, and the latter is then caused to become supersaturated by sudden cooling, condensation takes place. The gas ions here act as nuclei for the water drops that form, just as dust particles are known to do. The amount of water condensed can be calculated from the degree of supercooling, while the size of the drops is determined from the rate at which they settle. Hence the number of drops is known, and indirectly the number of ions that served as nuclei for the drops. Knowing the total charge, the charge per individual ion is thus found. By this formation of a mist the individual gas ions can, as it were, be made visible to the eye.

Thus the farthest advances of modern science, which have taxed to the utmost the experimental resources of our most eminent men of science, seem to bear out in every way the atomistic conception of matter. The insight into the inner structure of colloidal solution and the nature of the Brownian movement, which the ultramicroscope has revealed, as well as the results of investigations of ionized gases, seem to furnish proof positive of the discontinuous structure of matter, discerned intuitively by the mental eye of the Greek sage two and a half thousands of years ago.—Zeit. f. aug. Chemie.

SUCTION-GAS TUG BOATS ON THE RHINE.

THE new suction-gas tug boat "Knipscheer II," belonging to Ruhrort, which made its trial trips in the spring of this year, began its haulage duties a few weeks ago up the Rhine to Mannheim and back, towing cargoes of 350 tons in two barges. These trips proved perfectly successful, and have demonstrated the reliability of the system, especially the extraordinary saving in coal. Owing to the strong down-stream currents in the Rhine, the tug business has hitherto always been a precarious one; but the new method of using gas engines has resulted in considerable economies, as the cost of fuel is less by 50 to 70 per cent than that of the existing steam tugs. A further difficulty has been overcome. During the summer months the great heat in the Rhine valley causes the stokers on the steam tugs much distress, and high wages have to be paid to get men at all. In the suction-gas tugs only ordinary laborers are required, and the fuel is fed into the producers by a simple automatic arrangement. For fuel, the producers use lignite in place of coal or slack. This brown coal is mined in the Rhine provinces, and can be brought alongside the river at Wesseling at very small cost. The lignite industry will therefore profit considerably by the new departure in hauling. Those who travel by rail along the banks of the Rhine have noticed the great nuisance caused by the dense smoke emitted by the steam tugs—a smoke that spoils the riverside residences, townships, and vineyards between Mayence and Cologne. If gradually the present boats are superseded by the new suction-gas tugs, it will be a great blessing to inhabitants and tourists alike. For some time past tug owners have been prosecuted by the authorities on account of this smoke nuisance; they will now welcome the success of a smokeless method of haulage, especially as it is also a more economical method. The gas engines on the new tugs were supplied by the Deutz Gas Engine Company; the important reversing gear, together with the main shafts and propellers, were manufactured by Messrs. Lünnemann, of Ruhrort. The consulting engineer, who made the preliminary investigations into the application of gas power for these tugs, was Herr Zander, who also designed and superintended the construction of the boats. The trial trips and the first working trips were carried out under the supervision of Herr W. Lünnemann, of Ruhrort.—Engineering.

Shifting sand dunes are causing trouble on the borders of Lake Michigan, according to Bulletin 7 of the Illinois Geological Survey. The dunes are formed by the on-shore winds, which sweep the beach sand beyond the reach of the waves. The sand accumulates in low mounds about any obstructions, such as stones or bushes; thus started the dune is sufficient cause for its own growth. The wind keeps piling the sand up from behind, the dune grows, and the sand on its crest is blown over to the leeward side of the mound, so that the dunes gradually march inland. On the east side of Lake Michigan the dry west winds have heaped up numbers of dunes, ranging in height up to 200 feet. In Indiana the dunes have moved inland across a forested area, burying and killing trees, leaving the dead trunks skeletons behind them in their march onward. A famous instance of dune migration is that of the Kurische Nehrung, a long sand bar off the coast of Germany, where a dune ridge marched over a church, burying it for thirty years, at the end of which time it was gradually uncovered by the progress of the dune.

CANNING AND PRESERVING FRUIT.—III.*

HINTS FOR THE HOUSEWIFE.

BY MARIA PARLOA.

Continued from Supplement No. 1754, page 110.

CANNING FRUIT.

THIS method of preserving fruit for home use is from all points the most desirable. It is the easiest and commonly considered the most economical and the best, because the fruit is kept in a soft and juicy condition in which it is believed to be easily digested. The wise housekeeper will can her principal fruit supply, making only enough rich preserves to serve for variety and for special occasions.

The success of canning depends upon absolute sterilization. If the proper care is exercised there need be no failure, except in rare cases, when a spore has developed in the can. There are several methods of canning; and while the principle is the same in all methods, the conditions under which the housekeeper must do her work may, in her case, make one method more convenient than another. For this reason three will be given which are considered the best and easiest. These are: Cooking the fruit in the jars in an oven; cooking the fruit in the jars in boiling water; and stewing the fruit before it is put in the jars. The quantity of sugar may be increased if desired.

It is most important that the jars, covers, and rubber rings be in perfect condition. Examine each jar and cover to see that there is no defect in it. Use only fresh rubber rings, for if the rubber is not soft and elastic the sealing will not be perfect. Each year numbers of jars of fruit are lost because of the false economy in using an old ring that has lost its softness and elasticity. Having the jars, covers, and rings in perfect condition, wash and sterilize them.

Have two pans partially filled with cold water. Put some jars in one, laying them on their sides, and some covers in the other. Place the pans on the stove where the water will heat to the boiling point. The water should boil at least ten or fifteen minutes. Have on the stove a shallow milk pan in which there is about 2 inches of boiling water. Sterilize the cups, spoons, and funnel, if you use one, by immersing in boiling water for a few minutes. When ready to put the prepared fruit in the jars slip a broad skimmer under a jar and lift it and drain free of water. Set the jar in the shallow milk pan and fill to overflowing with the boiling fruit. Slip a silver-plated knife or the handle of a spoon around the inside of the jar, that the fruit and juice may be packed solidly. Wipe the rim of the jar, dip the rubber ring in boiling water and put it smoothly on the jar, then put on the cover and fasten. Place the jar on a board and out of a draft of cold air. The work of filling and sealing must be done rapidly, and the fruit must be boiling hot when it is put into the jars. If screw covers are used, it will be necessary to tighten them after the glass has cooled and contracted. When the fruit is cold wipe the jars with a wet cloth. Paste on the labels, if any, and put the jars on shelves in a cool, dark closet.

In canning, any proportion of sugar may be used, or fruit may be canned without the addition of any sugar. However, that which is designed to be served as a sauce should have the sugar cooked with it. Fruit for cooking need not have the sugar added to it.

Juicy fruits, such as berries and cherries, require little or no water. The only exception to this is when they are cooked in a heavy syrup.

Raspberries.

12 quarts of raspberries.
2 quarts of sugar.

Put 2 quarts of the fruit in the preserving kettle; heat slowly on the stove; crush with a wooden vegetable masher; spread a square of cheese cloth over a bowl, and turn the crushed berries and juice into it. Press out the juice, which turn into the preserving kettle. Add the sugar and put on the stove; stir until the sugar is dissolved. When the syrup begins to boil, add the remaining 10 quarts of berries. Let them heat slowly. Boil ten minutes, counting from the time they begin to bubble. Skim well while boiling. Put in cans and seal as directed.

Raspberries and Currants.

10 quarts of raspberries.
3 quarts of currants.
2½ quarts of sugar.

Heat, crush, and press the juice from the currants and proceed as directed for raspberries.

Blackberries.

The same as for raspberries.

Currants.

12 quarts of currants.
4 quarts of sugar.

Treat the same as for raspberries.

Gooseberries.

6 quarts of berries.
1½ quarts of sugar.
1 pint of water.

For green gooseberries dissolve the sugar in the water, then add the fruit and cook fifteen minutes. Ripe gooseberries are to be treated the same as the green fruit, but use only half as much water. Green gooseberries may also be canned the same as rhubarb.

Blueberries.

12 quarts of berries.
1 quart of sugar.
1 pint of water.

Put water, berries, and sugar in the preserving kettle; heat slowly. Boil fifteen minutes, counting from the time the contents of the kettle begin to bubble.

Cherries.

6 quarts of cherries.
1½ quarts of sugar.
½ pint of water.

Measure the cherries after the stems have been removed. Stone them or not, as you please. If you stone them be careful to save all the juice. Put the sugar and water in the preserving kettle and stir over the fire until the sugar is dissolved. Put in the cherries and heat slowly to the boiling point. Boil ten minutes, skimming carefully.

Grapes.

6 quarts of grapes.
1 quart of sugar.
1 gill of water.

Squeeze the pulp of the grapes out of the skins. Cook the pulp five minutes and then rub through a sieve that is fine enough to hold back the seeds. Put the water, skins, and pulp into the preserving kettle and heat slowly to the boiling point. Skim the fruit and then add the sugar. Boil fifteen minutes.

Sweet grapes may be canned with less sugar; very sour ones may have more.

Rhubarb.

Cut the rhubarb when it is young and tender. Wash it thoroughly and then pare; cut into pieces about 2 inches long. Pack in sterilized jars. Fill the jars to overflowing with cold water and let them stand ten minutes. Drain off the water and fill again to overflowing with fresh cold water. Seal with sterilized rings and covers. When required for use, treat the same as fresh rhubarb.

Green gooseberries may be canned in the same manner. Rhubarb may be cooked and canned with sugar in the same manner as gooseberries.

Peaches.

8 quarts of peaches.
1 quart of sugar.
3 quarts of water.

Put the sugar and water together and stir over the fire until the sugar is dissolved. When the syrup boils skim it. Draw the kettle back where the syrup will keep hot but not boil.

Pare the peaches, cut in halves, and remove the stones, unless you prefer to can the fruit whole.

Put a layer of the prepared fruit into the preserving kettle and cover with some of the hot syrup. When the fruit begins to boil, skim carefully. Boil gently for ten minutes, then put in the jars and seal. If the fruit is not fully ripe it may require a little longer time to cook. It should be so tender that it may be pierced easily with a silver fork. It is best to put only one layer of fruit in the preserving kettle. While this is cooking the fruit for the next batch may be pared.

Pears.

If the fruit is ripe it may be treated exactly the same as peaches. If, on the other hand, it is rather hard it must be cooked until so tender that a silver fork will pierce it readily.

Quinces.

4 quarts of pared, cored, and quartered quinces.
1½ quarts of sugar.
2 quarts of water.

Rub the fruit hard with a coarse crash towel, then wash and drain. Pare, quarter, and core; drop the pieces into cold water. Put the fruit in the preserving kettle with cold water to cover it generously. Heat slowly and simmer gently until tender. The pieces will not all require the same time to cook. Take each piece up as soon as it is so tender that a silver fork will pierce it readily. Drain on a platter. Strain the water in which the fruit was cooked through cheese cloth. Put two quarts of the strained liquid and the sugar into the preserving kettle; stir over the fire until the sugar is dissolved. When it boils skim well and put in the cooked fruit. Boil gently for about twenty minutes.

Crab Apples.

6 quarts of apples.
1½ quarts of sugar.
2 quarts of water.

Put the sugar and water into the preserving kettle. Stir over the fire until the sugar is dissolved. When the syrup boils skim it.

Wash the fruit, rubbing the blossom end well. Put it in the boiling syrup, and cook gently until tender. It will take from twenty to fifty minutes, depending upon the kind of crab apples.

Plums.

8 quarts of plums.
2 quarts of sugar.
1 pint of water.

Nearly all kinds of plums can be cooked with the skins on. If it is desired to remove the skin of any variety, plunge them in boiling water for a few minutes. When the skins are left on, prick them thoroughly to prevent bursting.

Put the sugar and water into the preserving kettle and stir over the fire until the sugar is dissolved. Wash and drain the plums. Put some of the fruit in the boiling syrup. Do not crowd it. Cook five minutes; fill and seal the jars. Put more fruit in the syrup. Continue in this manner until all the fruit is done. It may be that there will not be sufficient syrup toward the latter part of the work; for this reason it is well to have a little extra syrup on the back of the stove.

Stewed Tomatoes.

Wash the tomatoes and plunge into boiling water for five minutes. Pare and slice, and then put into the preserving kettle; set the kettle on an iron ring. Heat the tomatoes slowly, stirring frequently from the bottom. Boil for thirty minutes, counting from the time the vegetable begins actually to boil. Put in sterilized jars and seal.

Whole Tomatoes.

8 quarts of medium-sized tomatoes.
4 quarts of sliced tomatoes.

Put the pared and sliced tomatoes into a stew pan and cook as directed for stewed tomatoes. When they have been boiling twenty minutes take from the fire and rub through a strainer. Return to the fire.

While the sliced tomatoes are cooking, pare the whole tomatoes and put them in sterilized jars. Pour into the jars enough of the stewed and strained tomato to fill all the interstices. Put the uncovered jars in a moderate oven, placing them on a pad of asbestos or in shallow pans of hot water. Let the vegetable cook in the oven for half an hour. Take from the oven and fill to overflowing with boiling hot, strained tomato, then seal. If there is any of the strained tomato left, can it for sauces.

Canned Fruit Cooked in the Oven.

This method of canning fruit, in the opinion of the writer, is the one to be preferred. The work is easily and quickly done, and the fruit retains its shape, color, and flavor better than when cooked in the preserving kettle.

Cover the bottom of the oven with a sheet of asbestos, the kind plumbers employ in covering pipes. It is very cheap and may usually be found at plumbers' shops. If the asbestos is not available, put into the oven shallow pans in which there are about 2 inches of boiling water.

Sterilize the jars and utensils. Make the syrup; prepare the fruit the same as for cooking in the preserving kettle. Fill the hot jars with it, and pour in enough syrup to fill the jar solidly. Run the blade of a silver-plated knife around the inside of the jar. Place the jars in the oven, either on the asbestos or in the pan of water. The oven should be moderately hot. Cook the fruit ten minutes; remove from the oven and fill the jar with boiling syrup. Wipe and seal. Place the jars on a board and out of a draft of air. If the screw covers are used tighten them after the glass has cooled.

Large fruits, such as peaches, pears, quinces, crab apples, etc., will require about a pint of syrup to each quart jar of fruit. The small fruit will require a little over half a pint of syrup.

The amount of sugar in each quart of syrup should be regulated to suit the fruit with which it is to be used. The data already given will be a guide. The quantities given will not make the fruit very sweet. The quantity of sugar may be increased or diminished to suit the taste.

(To be concluded.)

* Reprint of Farmers' Bulletin 393, issued by the Department of Agriculture.

HOW TO JOIN ELECTRIC WIRES.

SUGGESTIONS FOR THE AMATEUR.

Before an amateur can attain any proficiency in the art of electric lighting, fitting bells, or telephony, it is essential that he should be able to connect wires or cables together properly. This may sound an easy job, but it is not so, and the slipshod connections made by bad workmen is the chief cause of faulty electric bells, inefficient and indistinct communication in telephony, and (if passed by fire offices) serious trouble in electric lighting.

The making of all joints in electric wiring is always intrusted to a careful man, as a single badly-made joint not only puts the whole installation out of order, but the difficulty and annoyance in locating and remedying the defect is often very great.

It is the best plan to do without joints altogether, even if extra wiring is required, as the initial cost of the wire is not a great item, and a few yards, more or less, matters little, especially when the time and trouble in making the joint is taken into account. Suppose, for instance, that we have a house bell ringing from two pushes, as shown diagrammatically in Fig. 1. Joints will be required normally at the parts marked *A*, but if the system of looping in the wiring is adopted, the joints mentioned will not be needed. All that is necessary is to take the wiring down to the push, give it a turn or two round the stem of the terminal screw, and take to the bell in the usual manner. Of course, the insulation must be stripped off an inch or more, in order that this may be done; and

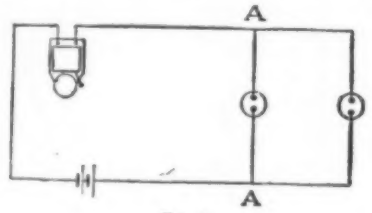


Fig. 1.

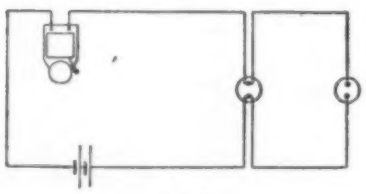


Fig. 2.

perhaps another hole will have to be made, or, at any rate, a larger one may be required in some devices, such as bell pushes.

An ordinary electric bell push is shown with the top removed in Fig. 3, and this is the kind of push which would be used in Fig. 2. The two contact pieces are fixed to the base by screws, where indicated by the black dots, *a a*. The center holes ordinarily take the screws for fixing the ends of the wires as shown, but, in looping the wiring, the holes are made larger and the wires are stripped of their insulation, as previously explained, and bent, as in Fig. 4, and passed in the holes, finally binding round underneath the screw-heads in the usual manner. Occasions, however, often arise in which joints are absolutely necessary, either on the score of the expense of the extra wiring, or for other reasons. We, therefore, consider the easiest and most efficient kind of joints.

Take, as first example, the connection of one wire to a main at right angles, as at *A*, Fig. 1. The first step is to strip off the insulation for two or three inches on the main wire, and about the same or a little less on the branch wire. Thoroughly clean the bare metal with emery, and wind the end of the branch wire round the main wire. Next solder the spiral part, marked *B*, Fig. 5, but do not carry the solder along the part *C*, because any stress or side-play on this part would break off the solder. This is the sort of thing which happens, if the branch wire is taken straight off at right angles, instead of laying it along the wires as at *C*. The joint is then trimmed and the insulation restored to it. This covering operation must be done thoroughly, or leakage of current cannot at some time or other be avoided. The insulation is generally wound on, spiral fashion, so that it is a fairly easy matter to wind on again. Should it be required to join two short lengths of wire, then the joint, Fig. 6, can be employed, using thin copper binding wire to make a good contact. Large single wires can be cut beveled fashion, as in Fig. 7, and then bound with wire and soldered, etc., as before.

When several wires are bound together under the same insulation, the combination is called a cable, and these are used in small electric lighting installations, in order to make the resultant wire flexible. In jointing such wires, each individual strand is cleaned before commencing to connect. Fig. 8 shows the first stage, and Fig. 9 the final way of binding before soldering, while Fig. 10 shows the joint ready for taping. Continuous jointing is shown in Figs. 11 and 12, and

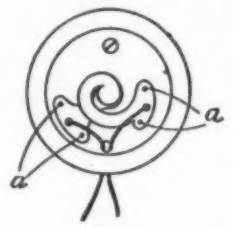


Fig. 3.

Fig. 4.

these figures are self-explanatory. The taping and outer covering is restored, making the resultant joint rather more bulky than the plain wiring.

Another method of uniting two lengths of cable in one and the same straight line is to solder the metal wires into a solid mass all round the circumference of the wires, then scarf or bevel them together, as indicated in Fig. 7.

Always bear in mind that it is a perfect metal to metal contact, and see that nothing intervenes to produce oxidation. This is prevented if carefully cleaned and well soldered. A good-sized soldering iron is best for this work, and one that has a groove in the end for resting the wire in. Have the soldering iron perfectly clean, and hot, and use only resin as a flux. No acid or salts must on any account be used. Any rough points of wire or solder must be filed off before restoring tape. In removing the insulation, do not nick the metal wire, especially for electric light work. A careful study of the illustrations which are given will make the whole process perfectly clear.—Home Handicrafts.

THE EGNER-HOLMSTROM TELEPHONE APPARATUS.

This new invention, which has recently been tested with great success, inasmuch as easy and entirely satisfactory telephonic conversations took place between Sundsvall, North Sweden, and Paris, *via* Copenhagen, with Copenhagen in the line for hearing, has attracted much attention in all interested quarters. The two inventors, both engineers on the staff of the Swedish State Telegraphs, have for several years been engaged in experiments for the purpose of improving the telephone, and have also brought about valuable improvements in the microphone, but the recent long-distance telephone experiments have not referred to these inventions but to the use of heavy power currents instead of the comparatively feeble currents of ordinary telephone work. This makes it possible to increase the dispatched energy current at will, and with an energy forty times that hitherto reached; it has been possible to telephone double the distance that was possible with the ordinary equipment. Experimenting has been going on between Berlin-Copenhagen-Stockholm and between Berlin-Cologne-Hamburg-Stockholm, and now most recently between Paris and Sundsvall. It was also the intention to experiment by way of London-Paris-Copenhagen, but owing to the less satisfactory state of the Channel cables, this plan has in the meantime been abandoned. With special arrangements it had hitherto been possible to telephone a distance of 1,800 to 2,000 kilometers by using expensive 4.5 to 5 millimeter copper wire, but this distance was considerably reduced when wire of smaller dimensions, or submarine cables, were inserted in the line. The two inventors saw that a new departure would have to be made, and their first efforts were to construct a microphone capable of standing a comparatively heavy current, which naturally would increase the distance over which telephonic conversation could be carried on. Their experiments, which commenced in February, 1907, had, as early as the beginning of 1908, been carried so far that the principles had become clear. A new apparatus was constructed, based upon these principles, and in March, 1908, the first experiments were made on the Berlin-Stockholm line; the result was excellent, but the inventors preferred to keep silent about it pending the perfecting of the method. Both the Swedish and the German authorities have done all in their power to facilitate the experiments, and conversations with the new apparatus have taken place between Geheimepostrat Braun, in Berlin, and General-Director Rydin in Stockholm. The experiments carried on in Sweden have given the following results as to the respective capacity of the ordinary Swedish State telephone apparatus and that of the Egner-Holmstrom type:

	Longest Distance in Kilometers with Ordinary State Telephone Apparatus.	Conversations Carried on through the New Apparatus over the Following Distances, in Kilometers.
With 3-millimeter copper-wire line	1,000-1,200	2,000
With 4.5-millimeter copper-wire line	1,800-2,000	4,000
With 3-millimeter iron-wire line	180-200	400

In all these experiments the microphone current used for the new apparatus was from 1 to 1.25 amperes. If the strength of the current is increased, there should be no difficulty in talking over almost any distance, but at present there is hardly any reason to go in for a microphone current stronger than the one mentioned above. The invention is also expected to prove of considerable importance in the matter of wireless telephony.—Engineering.

Enamels, as used for artistic ornamentation, are prepared as follows: Melt together, for Transparent Red: 65 parts Cassius gold-purple, 3,000 parts crystal glass, 400 parts borax. Transparent Blue: 34 parts crystal glass, 6 parts borax, 4 parts oxide of cobalt. Dark Blue: 30 parts crystal glass, 6 parts borax, 4 parts oxide of cobalt, 4 parts bone charcoal, 2 parts arsenic acid. Violet: 30 parts crystal glass, 4 parts borax, 4 parts manganese, 1.2 part oxide of cobalt. Transparent Green: 80 parts crystal glass, 4 parts oxide of copper, 2 parts borax. Dark Green: 30 parts crystal glass, 8 parts borax, 4 parts oxide of copper, 4 parts bone charcoal, 2 parts arsenic acid. Black: 30 parts crystal glass, 8 parts borax, 4 parts oxide of copper, 3 parts oxide of iron, 4 parts oxide of cobalt, 4 parts oxide of manganese. White (I): 30 parts of crystal glass, 6 parts oxide of tin, 6 parts borax, 2 parts arsenic acid. White (II): 30 parts crystal glass, 10 parts antimonate of soda. The colored enamel, powdered as fine as possible, is applied, by means of a brush, with oil of lavender, to the already fused-on white enamel and then heated just to the melting point. For certain purposes, the colored compounds may be melted by themselves, without white foundation. It must, however, be noted that in White No. II no glass containing lead must be used, otherwise one will obtain an enamel of unsightly appearance.

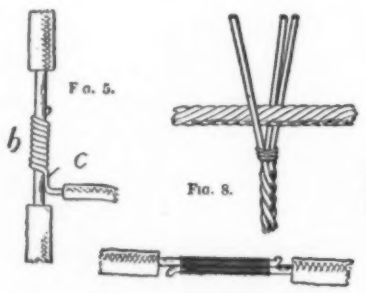


Fig. 5.

Fig. 8.

Fig. 6.

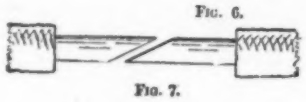


Fig. 7.

Fig. 9.

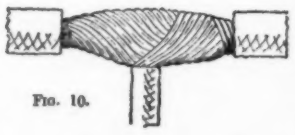


Fig. 10.

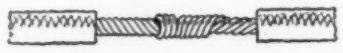


Fig. 11.

Fig. 12

TOPOGRAPHICAL AND OTHER MODELS.*

HOW THEY ARE MADE.

BY STANLEY C. BAILEY, A.M.I.C.E., F.G.S.

IT is sometimes necessary, when designing buildings or other works, and for exhibitional, educational, or legal purposes, to construct models, in order to explain intricate points more clearly than can be shown by drawings. For making models of buildings, there is no material more suitable than well-seasoned red, or yellow, pine, free from cracks, shakes, and knots. The wood should be well planed, and when finished, it should be glass-papered before being painted with oil colors to represent the various materials used in the construction of the building. Thin sheet zinc (No. 27 S.W.G., weighing 9.8 ounces per square foot) may be employed for various parts where thinness and strength are required, such as for slates and partitions, or millboard may be used where substantial work is not necessary. The roof and walls should be put together in such a way that they can be readily taken to pieces in order to show the interior; this can be done by using small brass hinges at the corners of the model of the building, and by screwing the work together on a ground board or base. The base-board will vary in thickness according to the size of the model, and should be made of a number of boards glued and doweled together at their edges, and fitted with a chamfered or molded border of wood glued and nailed to the edges. Two laths or battens should be screwed to the underside of the board to prevent warping, and to enable the model to be lifted, if it is not fitted with handles for this purpose.

French wire nails are more suitable than cut nails for use in the construction of models, and dowels made of wire nails with the heads cut off will be found more convenient than hard wood. Staircases for a small model of a house are best cut out of a solid piece of wood with a tenon-saw; but for a large one, the string-

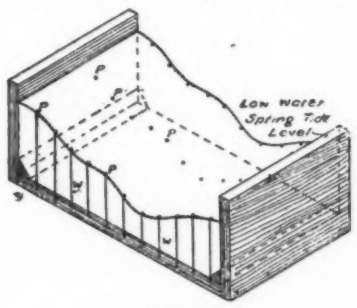


FIG. 1.

ers may be cut out of wood, and the treads and risers out of zinc, fastened by small wire nails to the stringers. Window openings are, as usual, filled in with glass, the sash bars being painted on in oil colors; the glass can be held in position on the inside of the model by tacks driven into the wood close against the edge of the glass, or by gluing rebated fillets of wood to the model round the glass, so as to form an architrave. Balusters may be formed of wire nails with the heads cut off so as to be easily inserted in the underside of the wooden handrail.

Where turned work is required, such as for chimney pots, pillars, etc., and there is no lathe convenient, pieces cut from broom handles and wooden curtain rods, of various diameters to suit the scale of the model, will be found suitable. Lead flashings, aprons, and gutters can be easily shaped out of tinned iron or thin zinc (No. 32 S.W.G., weighing 6½ ounces per square foot), or even out of thin lead sheeting, the rain-water pipes and bends out of small lead tubing, or wooden rods, fixed by tinned iron clips and tacks to the walls of the model.

In order to represent "rough cast" work on the walls, coat them with gum arabic, or with a thin wash of glue, and, while wet, sprinkle fine pit- or sea-sand over them, or spread it over with a knife. The sand should be clean and quite dry; it is advisable, before using it, to wash it well in a bucket, stirring it up, and pouring out the muddy water, then adding more water, and repeating the process until the water is almost clear; then, spread the sand out on an old tray, and dry it in a slow oven. Joints in brickwork and masonry are best shown by setting them out with a pencil, after the work has been painted a suitable color. For fireplaces, small model ones in tinned iron can be obtained, and if not of a suitable scale they may be made out of a block of wood, the fireplace being scooped out with a gouge, and the mantelpiece made of zinc.

In landscape work, trees and shrubs may be represented by bushy twigs cut from shrubs; these twigs should be smeared with gum, and then dipped into a box containing green paper of various shades, cut up finely to represent leaves. Lawns and grass can be shown by pieces of green baize cloth gummed down to the ground board, plowed land by brown cloth, and long jungle grass and crops by matting dyed to suitable colors. Roads and foot paths are best made by

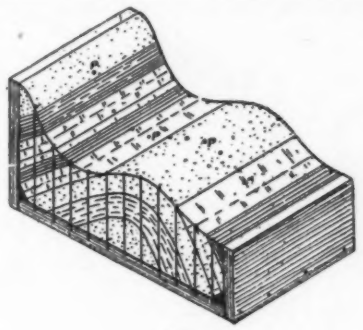


FIG. 2.

coating the surface with gum or thin glue, and sprinkling with fine dry clean sand, or spreading it on with a knife. Water is best represented by a sheet of glass laid on a blue painted surface and held down by tacks close to the edges.

Rocks of a particular shape are easily carved out of a lump of chalk to the required form, and can be fixed to the baseboard with a thick bed of glue. For a model rockery any stones may be used, the lower ones being laid in a bed of sand and glue, or gum arabic, mixed into a paste; this will adhere firmly to the board, and also to the stones. The upper stones may be similarly fixed, or neat Portland cement mixed with water, or plaster of Paris mixed with gum can be used, and will be found satisfactory. Moss and grass, etc., may be represented by patches of yellow or green cloth gummed to the stones, or by painting them in oil colors.

In order to make a contour model of, say, the bottom of a river or a harbor, the most suitable material to use is plaster of Paris; but as neither this nor Portland cement, when mixed with water, will stick to wood, the best plan is to mix the lower layer (say, a quarter of an inch thick or less) with gum or thin glue, which will cause the plaster to stick readily to the wooden baseboard, the upper portion of the model being made of plaster mixed with water in the usual way, into a thick paste, which will set in about an hour. Having procured a chart giving the soundings in fathoms below low water of ordinary spring tide, contour lines should be run through all the soundings of equal depth, say at 1, 2, 3, 4, and 5 fathoms, etc. If the scale decided upon for the model be larger than that of the chart, an enlarged plan will be required; this can be made either with a pantograph or by dividing the chart into squares by pencil lines, and drawing a similar number of squares on the new plan to the enlarged scale; the relative positions of the soundings can then be laid down on the plan, and the contour

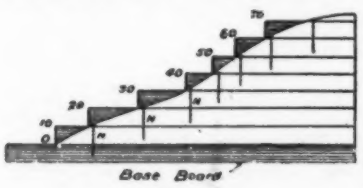


FIG. 3.

lines put in. This new plan should preferably be drawn on tracing paper, or on the rough side of tracing cloth; but if the lines are drawn in with Indian ink, the cloth will require to be powdered with chalk, or rubbed with a piece of whiting, and then rubbed over with a cloth duster, in order to take the greasiness off the surface before the ink is put on. When the plan has been prepared, it should be laid on the board forming the base of the model, and either pinned or gummed down at the corners. Small holes, about ¼ inch deep, made with a 1/16-inch brad awl, should now be made in the board along the various contour lines at suitable intervals apart, say, at every inch or so, according to the scale of the model, and short lengths of galvanized iron wire of No. 17 or 18 standard wire gage should be driven vertically into the holes, and cut off with a pliers at the depths of the various contours, the level of the board being that of the lowest contour or sounding on the chart.

The plan should now be removed, and a wooden border screwed to the base-board, so as to form a box, the tops of the border boards being planed level to the height of low water of ordinary spring tide. Fig. 1 represents a portion of such a model; the contour points are shown at *P*, and the wires *W* giving the levels at those points. The plaster of Paris should be well mixed with gum or water, as the case may be, to a thick paste, and spread over the board to the levels of the tops of the various contour wires, thus forming an accurate representation of the bottom of the harbor, etc. When quite dry, the positions of the ground, or bottom moorings, etc., can be painted in oils on the plaster, and if the character of the bottom varies, the rocks, gravel, sand, and mud may be shown in distinctive colors. As the tops of the wires will show on the surface of the plaster, the contour lines may be painted on the model with a fine brush.

The advantage of having a plaster model is, that when any dredging is done, the plaster can easily be cut away, leaving the wires in position to show the original depths; any silting-up may also be shown by additions of plaster where required, the depths being gaged from a "straight-edge" placed across the model. Topographical models of districts may also be made of plaster of Paris in a similar manner, as shown by a portion of a geological section in Fig. 2, the various strata being colored; but it will be found better, in many cases, to construct them of wood as follows: A contoured plan, as represented in Fig. 3, should be prepared from the map of the district to be depicted, laid on the base-board, and well pinned down. The line representing the sea level, or the lowest contour,

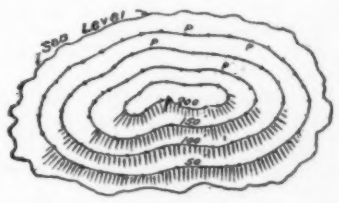


FIG. 4.

should then be gone carefully over with a hard pencil; this will leave a mark on the board, which should be penciled over after the plan is removed.

Having decided upon the vertical scale of the model, which is usually made greater than the horizontal—say it is to be ¼ inch for every 50 feet in height, and that the contours are 50 feet apart vertically—procure well-planed boards of wood, without knots or cracks, each ¼ inch thick, and set out from the plan the sea level or lowest contour on one of the boards, and also the next highest contour line, on the same board; remove the plan, and pencil in the lines, then cut the board away with a fret-saw round the sea level or lowest contour line, as the case may be.

This board should now be laid on the base-board in such a way that its profile coincides with the sea-level line already laid down on that board. It may be fastened with glue and wire nails, taking care that the nails are driven into the wood on the inside of the contour lines, as shown in the section, Fig. 4. The process should be repeated for each set of contours, each board being cut out to the line of the lower contour, then glued and nailed down on top of the lower boards. When complete, the "steps," or "risers," should be carefully cut away with chisels and gouges, and the surface afterward smoothed down with sand or glass paper.

To prevent warping of the model, the base-board should be ¾ inch to 1 inch thick, and the other boards should be laid with the grain of the wood at right angles to the contiguous pieces.

It is stated that a start has already been made at Rheinau, near Mannheim, with the building of Prof. Schuette's airship, which will be constructed on the rigid system, like the "Zeppelins," but will be considerably larger, and have a wooden instead of an aluminium framework. As it will be provided with four motors, aggregating 500 horse-power, it is also hoped to obtain much higher speeds than are possible with any existing airship.

* English Mechanic and World of Science.

DEEP SEA SOUNDING APPARATUS.

SOME RECENT IMPROVEMENTS.

BY CAPT. E. MOLL.

JUDICIAL investigations of cases of stranding of ships show a continual recurrence of certain sins of omission, and especially of insufficient soundings, which cause nearly three-fourths of the total number of disasters. One reason for the neglect of soundings is that the vessel must be stopped or its speed greatly diminished in order to take soundings with the lead and line. As merchant captains wish to make port as quickly as possible they are reluctant to delay their vessels by making soundings except in cases of obvious necessity.

For this reason men of science and practical seamen have made many attempts to devise apparatus by which soundings could be taken without reducing the speed of the vessel or deviating from the course. Many devices of more or less utility were constructed before Kelvin's inventive genius furnished a complete solution of the problem and an apparatus which satisfies every requirement of practice. The first apparatus of this sort was installed on the cable steamer "Faraday" in 1874. Since that time the apparatus has been so greatly improved that trustworthy soundings can now be taken from express steamers at full speed. All warships and mail steamers are now equipped with Kelvin's apparatus.

The depth of water is determined by sinking a vertical glass tube, closed at the top, open at the bottom, and coated internally with silver chromate. The glass tube is inclosed in a brass case, which is perforated below and may be closed or opened above by a valve. The tube and its case are fastened, above the lead, to a short line attached to a light wire cable coiled on a capstan. When this sounding apparatus is thrown overboard it sinks very rapidly, as little friction is developed by the small wire cable. Water enters the glass tube, compressing the air above it, and rises to a height proportional to the external hydrostatic pressure and, consequently, to the depth to which the tube has descended. The sea water converts the red silver chromate which it touches into white silver chloride, so that when the tube is hauled up the height to which the water has risen within it is found sharply marked by the boundary between the white and red parts of the coating. The tube is applied to a specially constructed scale, and the scale division opposite this boundary gives directly the number of fathoms or meters to which the tube has descended.

Kelvin's apparatus has two defects. Each of the rather costly prepared tubes serves only for a single sounding, and the silver chromate in time becomes so altered that the level attained by the sea water is not sharply marked. In England numerous devices have been invented which are free from these defects, but not from the more serious one of dependence upon mechanical contrivances which may fail at the critical moment. Hence none of these English devices has been adopted in Germany. Hartig and Heuze have invented sounding apparatus in which a single glass tube is used repeatedly. Practical experiments made in the German navy and merchant fleet prove that this apparatus gives trustworthy results when the speed of the vessel is less than 12 or 14 knots, and indicate the probability that it will in time be made equally reliable at high peeds.

The so-called depth indicators are very useful in approaching land, when it is desirable to know the depth of water at every point of the course. The apparatus consists of a water kite towed by a small line to which it is attached obliquely, so that the pressure of the water on its front forces it downward, as the air pressure forces an aerial kite upward. The depth attained by the kite can be deduced from the length of the line, and the apparatus can be set for any desired depth by regulating the amount of line paid out. At the bottom of the kite is a pin which, on striking the sea bottom, detaches from the tow line the lower part of the bridle, causing the kite to trail and rise to the surface of the water. At the moment of release the line slackens and causes a bell to ring on the ship.

A practical and interesting device of this class is Heyn's indicator (Fig. 2), which consists of a box kite containing a metal air chamber connected by a hose with a manometer on board. When the apparatus is immersed water enters the air chamber, and the air in the chamber and tube is compressed to a degree which is indicated by the manometer and is proportional to the depth of immersion. The manometer may, therefore, be graduated to give the depth directly. This apparatus makes possible a continuous control of the depth at which it is towed and also instantly indicates the depth at which it strikes bottom. After striking it need not be hauled up but may be dragged along the bottom, indicating the depth at every point.

This apparatus is very well adapted for use in maritime surveying for it furnishes, probably, as accurate a profile of the sea bottom as can be obtained by any method. It cannot be used at speeds exceeding 14 knots and consequently it will find its chief usefulness

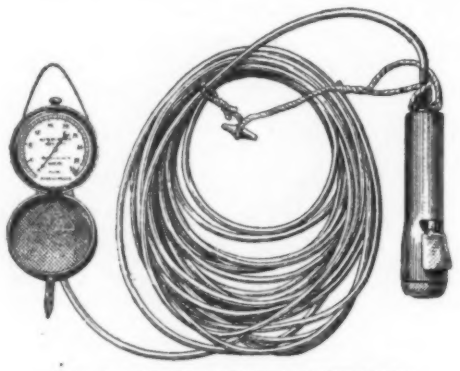


FIG. 1.—HEYN'S HAND SOUNDING APPARATUS.

in surveying and in the service of pilot boats, fishery police boats, and other slow-going vessels cruising within fixed limits in all weathers.

The same firm manufactures a hand sounding apparatus (Fig. 1) which is used like the ordinary lead line. The "lead," however, contains an air chamber connected to a hose with a manometer, which indicates the depth. In comparison with the ordinary lead line, this apparatus possesses the advantages that it can be equipped with equal certainty by night and by day, and that the distance between the leadsman and the point at which the sounding is made need not be taken into account. The moment of striking the sea bottom is indicated by the slackening of the line and also by the arrest of the index of the manometer. The latter instrument may be placed directly under the eye of the officer of the watch, so that no error can be introduced by carelessness on the part of the leadsman.

Both of these inventions of Heyn have been subjected to practical tests which prove their entire reliability.—Umschau.

THE SIXTH CONFERENCE OF THE INTERNATIONAL COMMISSION OF METEOROLOGY.

THE sixth conference of the International Commission of Meteorology was held at Monaco, March 31st to April 6th last, under brilliant auspices.

Prince Albert of Monaco, whose interest in the advancement of natural science is well known, extended magnificent hospitality to the visiting scientists, of whom about thirty were in attendance from all parts of Europe, besides two representatives from the United States—Mr. A. Lawrence Rotch, of the Blue Hill Observatory near Boston, and Mr. Willis L. Moore, chief of the United States Weather Bureau.

FIG. 2.—HEYN'S CONTINUOUS SOUNDING APPARATUS.

The Prince, who acted as honorary chairman, made the opening address in the splendidly decorated auditorium of the Oceanographic Museum, and reminded his audience that the first balloons equipped for scientific investigation of the oceanic atmosphere were sent up from Monaco. He referred also to that ship, "that swimming laboratory," which had been equipped by himself for the conduct of balloon investigations, and which had penetrated even into polar regions, where it discovered the isothermal zones signalized by Dr. Assmann and M. Teisserenc de Bort. At this point he took occasion to pay a graceful compliment to Dr. Hergesell, the present president of the commission, by saying that to his enthusiasm and zeal were due the credit of convincing him (the Prince) of the desirability and feasibility of such an expedition. He pointed out finally that oceanography and aerology were very closely allied subjects because of the intimate influence exerted upon the atmosphere by the ocean.

The remainder of the day was spent in the inspection of the Oceanographic Museum, probably the finest institution of the kind in the world, though not yet complete.

The subsequent sessions were occupied in the receiving of reports of work already accomplished and the proposition of plans for future work, especially for co-operative work, with the twofold view of the advancement of pure science and the increase of practical knowledge for the use of agriculturists and others and for the guidance of aeronauts.

Dr. Assmann made an extended report on the manufacture and use of rubber balloons for investigation, referring to the difficulty of preparing balloons fit for reaching a height of 20,000 meters or more, and especially advising great care in freeing the rubber from particles of dust and from air bubbles. A novelty proposed by him was the use of an inner balloon inclosed within an outer one. The inner one, holding the instruments, is first filled with hydrogen. The outer one is then expanded with hydrogen to a greater or less extent, according to the height at which it is desired that it shall burst.

This aroused interest, though some members maintained that the Hergesell system of tandem balloons was superior, because in this case the torn fragments of the second balloon act in a measure as a drag or anchor to the instrument-carrying balloon and prevent its being driven too far from the ship by winds or currents.

Dr. Assmann also described an instrument invented by him for determining as nearly as possible the influence of radiation in the stratum of inversion.

Privy Councilor Hergesell described an apparatus for the measurement of temperature of air or gas in the interior of balloons.

Mr. Rotch proposed a plan for common observation of kite ascensions. This was referred to a committee.

M. Teisserenc de Bort gave an address on the results of the determining of the height of registering balloons from the ground by means of triangulation in order to verify heights measured by the barometer. The measurements could be followed with the theodolite up to a height of 15,000 meters.

President Hergesell made a report on the results of the vertical speed of rubber balloons as a function of their ascensional power and on the use of pilot balloons for the determination of vertical air currents. He pointed out that experiments should be made in a lofty inclosed space in which all doors and windows could be shut, as in the Strasburg Cathedral.

A very interesting report was that given by Prof. Berson on the expedition undertaken by himself and Prof. Elias in East Africa for the study of the higher atmosphere in its conditions of wind and temperature in the Victoria Nyanza region, and on the east coast. A full description of this expedition will shortly appear in the SCIENTIFIC AMERICAN. Some of the conditions observed can not be at present explained. The Italian meteorologist, Prof. Palazzo, reported on the Italian expedition of 1908 to Zanzibar and East Africa, and President Hergesell on observations on the Peak of Teneriffe, and in the neighborhood.

Count Vives y Vich evoked great applause by the announcement that the Spanish government had determined to erect a permanent meteorological station upon Teneriffe.

The commission adjourned after accepting an invitation extended by the commandant of the Aeronautic Division of the Austrian Army to meet in Vienna in 1912.—Abstract from Illustrirte Aeronautische Mitteilungen.

THE DANGERS OF TRAFFIC.

THE PSYCHOLOGY OF ACCIDENTS.

TRAFFIC, which has increased a hundredfold within the past century, is attended with many dangers to life, limb, and property. These dangers increase with the growth of traffic, though not in the same proportion, owing to the steady improvement in the technical machinery and regulation of traffic, and to the improvement and increased employment of safety appliances.

The dangers incident to traffic flow from two distinct sources. The dangers of one class arise from the action of the imprisoned forces of nature which are employed in traffic. These dangers are of physical and technical character, and they are effectually combated by technical science. The other source of danger is found in the mind of the man who is either conducting the traffic or is merely conducting his own person through it.

These mental dangers are not so easily disposed of as the physical and technical dangers, for it is impossible to put into practice, or even to construct, a system of mental rules of safety based on simple scientific foundations. Furthermore, a large part of the mental rules of safety which have been acquired by experience must be learned anew by each generation, and cannot, like technical achievements, be bequeathed and inherited. Even the experience gained during an individual life is impaired in value by the effect of advancing age. Finally, the development of traffic continually brings forth new problems and phenomena, which cannot be mastered without long experience.

For these reasons the mental causes of danger in traffic are far more important than the physical causes. The dangers arising from these causes are numerous and varied and the application of experience to the prevention of future casualties is made difficult by the fact that we are dealing, not with the individual, but with the multitude.

The mental operations concerned in the avoidance of danger in traffic are perception, judgment, and action. The conditions and circumstances of the traffic must first be clearly perceived, their consequences and relative importance must then be estimated, and, finally, such action must be taken as will insure safety. Failure to perform correctly any one of these three successive operations will produce inappropriate action and disaster. In this connection defects in the organs of sense may be left out of consideration, for the peculiar dangers which threaten the blind, the near-sighted or far-sighted, the deaf and deaf mutes, epileptics and paralytics are not strictly psychological.

We will confine our attention to the sources of danger that lie deeper than the superficial organs of perception and are located in the brain or the mind. Here a conspicuous source of danger is found in the slowness with which sensory impressions are often transmitted to the mind. In many persons this retardation is due to insufficient action of the sensory stimulus. Such persons fail to see or hear the approaching danger, either because they are dull of sense or because they are inattentive. In some cases dullness of sense is a mental defect, innate or the result of disease, which makes its possessor unfit to cope with the perils of active life. Persons thus afflicted must keep aloof from the current of traffic, for their defect is incurable, unless it is due to lack of education and experience, in which case they can be trained to make better use of their perceptive faculties.

In normal human beings this serious defect is caused by lack of interest or attention. This is the most potent of all mental causes of danger in traffic. Either the attention is not as keen as the circumstances require or it is directed to other things, material or mental. In most cases the attention is distracted by external objects, and is so engrossed by the people and vehicles in the street, shop windows and the trivial incidents of street life that the conditions of traffic are not sufficiently regarded. The possible danger is perceived dimly or not at all, and when it becomes an actual danger and the attention is suddenly called to it, the mind is so occupied with other things that it cannot promptly direct the action required for safety.

The case is still worse when the mind is preoccupied with ideas and oblivious of all external things. This is common with deep thinkers and with persons oppressed by grief or care, or elated by joy or other intense emotion. In such persons the connection between mental perception and the organs of sense is obstructed and cannot be re-established instantaneously, though a delay of a fraction of a second may be fatal.

Nearly related to these causes of danger are indecision and haste. In both conditions the attention is keen enough, but in the former it flits aimlessly from one object to another too rapidly to distinguish between the important and the trivial, and the attention of the hasty man is focused on the goal of his purpose and oblivious of surrounding objects. His intelligence and will power are so engrossed with the quick accomplishment of his purpose that he is blind and deaf to everything else.

An apparent diminution of attention may be produced in another way. In every person acuteness of perception varies with the object and with the special sense employed. One sees better than he hears, while the ears of another are more reliable than his eyes. There are differences even within the field of a single sense organ. One perceives moving objects better than objects at rest, while the reverse is the case with another person. Hence, as the objects and movements encountered in traffic are exceedingly diversified these differences in perception come into play. A person may correctly perceive and appreciate part of the circumstances but neglect another part and, therefore, act inappropriately at the critical moment. For example, he may lay out a safe path through the tangled web of street traffic, but may incorrectly estimate the speeds of vehicles and the resultant displacement of this safe path in the next second.—Prometheus.

According to the Engineering Record, the residual color of the effluents from sand filters using the comparatively clear Merrimac River water is often sufficiently high to be objectionable to some consumers. With a view to discovering what improvement in the appearance of the water could be effected, the Massachusetts State Board of Health conducted experiments during 1907, using a filter containing 48 inches of sand of an effective size of 0.21 millimeter, and operated at the rate of 5,000,000 gallons per acre daily. Before entering the filter, the water was treated with 0.25 grain of sulphate of alumina, and allowed to settle for about nine and a half hours. The clogging of the sand made washing necessary, about once a month, which was done by allowing a stream of water about 2 inches deep to flow across the top of the filter and through the top inch of sand, which was stirred up with a rake. The results of the process were not so good, either in reducing the amount of color or removing bacteria, as filtration through the same depth of sand and at about the same rate without the use of coagulants.

CALENDAR FOR 200 YEARS.*

FROM THE INTRODUCTION OF NEW STYLE.

By CHARLES E. BENHAM.

OCT.	MAY	FEB. AUG. NOV.	MAR.	JUNE	SEP. DEC.	JAN. APR. JULY	14	1753 2	1754 3	1755 4	1756* 12	1757 7	1758 1	1759 2	1760* 10
								1761 5	1762 6	1763 7	1764* 8	1765 3	1766 4	1767 5	1768* 13
MAY	FEB. AUG. NOV.	MAR.	JUNE	SEP. DEC.	JAN. APR. JULY	OCT.	13	1769 1	1770 2	1771 3	1772* 11	1773 6	1774 7	1775 1	1776* 9
								1777 4	1778 5	1779 6	1780* 14	1781 2	1782 3	1783 4	1784* 12
FEB. AUG. NOV.	MAR.	JUNE	SEP. DEC.	JAN. APR. JULY	OCT.	MAY	12	1785 7	1786 1	1787 2	1788* 10	1789 5	1790 6	1791 7	1792* 8
								1793 3	1794 4	1795 5	1796* 13	1797 1	1798 2	1799 3	1800 4
MAR.	JUNE	SEP DEC.	JAN. APR. JULY	OCT.	MAY	FEB. AUG. NOV.	11	1801 5	1802 6	1803 7	1804* 8	1805 3	1806 4	1807 5	1808* 13
								1809 1	1810 2	1811 3	1812* 11	1813 6	1814 7	1815 1	1816* 9
JUNE	SEP. DEC.	JAN. APR. JULY	OCT.	MAY	FEB. AUG. NOV.	MAR.	10	1817 4	1818 5	1819 6	1820* 14	1821 2	1822 3	1823 4	1824* 12
								1825 7	1826 1	1827 2	1828* 10	1829 5	1830 6	1831 7	1832* 8
SEP. DEC.	JAN. APR. JULY	OCT.	MAY	FEB. AUG. NOV.	MAR.	JUNE	9	1833 3	1834 4	1835 5	1836* 13	1837 1	1838 2	1839 3	1840* 11
								1841 6	1842 7	1843 1	1844* 9	1845 4	1846 5	1847 6	1848* 14
JAN. APR. JULY	OCT.	MAY	FEB. AUG. NOV.	MAR.	JUNE	SEP. DEC.	8	1849 2	1850 3	1851 4	1852* 12	1853 7	1854 1	1855 2	1856* 10
								1857 5	1858 6	1859 7	1860* 8	1861 3	1862 4	1863 5	1864* 13
MAY	AUG.	FEB. MAR. NOV.	JUNE	SEP. DEC.	APR. JULY	JAN. OCT.	7	1865 1	1866 2	1867 3	1868* 11	1869 6	1870 7	1871 1	1872* 9
								1873 4	1874 5	1875 6	1876* 14	1877 2	1878 3	1879 4	1880* 12
AUG.	FEB. MAR. NOV.	JUNE	SEP. DEC.	APR. JULY	JAN. OCT.	MAY	6	1881 7	1882 1	1883 2	1884* 10	1885 5	1886 6	1887 7	1888* 8
								1889 3	1890 4	1891 5	1892* 13	1893 1	1894 2	1895 3	1896* 11
FEB. MAR. NOV.	JUNE	SEP. DEC.	APR. JULY	JAN. OCT.	MAY	AUG.	5	1897 6	1898 7	1899 1	1900 2	1901 3	1902 4	1903 5	1904* 13
								1905 1	1906 2	1907 3	1908* 11	1909 6	1910 7	1911 1	1912* 9
JUNE	SEP. DEC.	APR. JULY	JAN. OCT.	MAY	AUG.	FEB. MAR. NOV.	4	1913 4	1914 5	1915 6	1916* 14	1917 2	1918 3	1919 4	1920* 12
								1921 7	1922 1	1923 2	1924* 10	1925 5	1926 6	1927 7	1928* 8
SEP. DEC.	APR. JULY	JAN. OCT.	MAY	AUG.	FEB. MAR. NOV.	JUNE	3	1929 3	1930 4	1931 5	1932* 13	1933 1	1934 2	1935 3	1936* 11
								1937 6	1938 7	1939 1	1940* 9	1941 4	1942 5	1943 6	1944* 14
APR. JULY	JAN. OCT.	MAY	AUG.	FEB. MAR. NOV.	JUNE	SEP. DEC.	2	1945 2	1946 3	1947 4	1948* 12	1949 7	1950 1	1951 2	1952* 10
JAN. OCT.	MAY	AUG.	FEB. MAR. NOV.	JUNE	SEP. DEC.	APR. JULY	1								

SUN.	M.	T.	W.	THU.	F.	SAT.	1	8	15	22	29
M.	T.	W.	THU.	F.	SAT.	SUN.	2	9	16	23	30
T.	W.	THU.	F.	SAT.	SUN.	M.	3	10	17	24	31
W	THU.	F.	SAT.	SUN.	M.	T.	4	11	18	25	
THU.	F.	SAT.	SUN.	M.	T.	W.	5	12	19	26	
F.	SAT.	SUN.	M.	T.	W.	THU.	6	13	20	27	
SAT.	SUN.	M.	T.	W.	THU.	F.	7	14	21	28	

* Leap Year.

CALENDAR—1753 to 1952.

Under the year find its number. Take the month row in line with that number as the heading of the Week-table below. The week-day for any date in that year will be found in line with the figure representing the day of the month.

Ex.: 1877 2) June 24 = Sun.
Aug. 21 = Tues.

1844 (9) May 31 = Fri.
Feb. 29 = Thurs.

* Knowledge and Scientific News.

ENGINEERING NOTES.

In some experiments recently carried out on the efficiency of ceiling fan blades, the motor was suspended vertically from a ball bearing, and its torque —equal to that on the fan—balanced by a weight acting on an arm at right angles to the suspending rod. Air velocities were measured by anemometer, and the direction of drafts indicated by unspun silk fibers. Two, three, and four-bladed fans were tried of 5-foot over-all diameter, both flat and curved, at angles of 20 deg. to 26 deg., and speeds from 75 to 200 revolutions per minute. The cubic feet of air delivered per minute per watt supplied to blades is termed "the figure of merit." At a given speed and blade angle the energy imparted to the stream of air is approximately proportional to the number of blades. Although the figure of merit increases with reduction of speed, the efficiency of the blades falls off at the same time. Flat blades of 5-foot diameter should be set at about 25 deg., and run at about 170 revolutions per minute for the best results, but curved blades are superior. Owing to the slow speed of the motor its efficiency is barely 30 per cent, and it therefore appears that high-speed motors with reduction gear would be advantageous.

The cost of maintenance of pavements along street railway lines is large, because stones are raised on each side of the rail by the action of water which flows in between the rail and the bed of concrete on which it rests. The difficulty of obviating these troubles is due to the fact that the interstices between the rail and the cement are very narrow and cannot be filled with cement or with asphalt by the ordinary methods. Hot asphalt cools so quickly on contact with the cold wet rail that it penetrates very little. As a result of various experiments Simpson, director of the street railways of Preston, England, decided to heat the rail and through it the cement. Two large petroleum burners were used. The defective pavement having been removed, the site was dried and the burners were applied to both sides of the rail at once. When the rail had become very hot and dry the asphalt was poured in on one side and, as the rail was slightly raised at the same instant with tongs, the asphalt immediately flowed through to the other side as well. The process was first used three years ago and has given very satisfactory result, no further repairs having been required to the spot where it was applied. A short time ago it was necessary to raise the rail at this place. This was done with the greatest difficulty because of the strong adhesion between the asphalt and the rail and cement, which asphalt kept the whole length of the rail solidly fixed. Simpson concludes that street railway rails would be laid in the best condition and would be much more rigid than they now are if they were imbedded in asphalt. The asphalt used in these experiments was really a mixture of asphalt and oil, which was made rather soft in order to avoid danger of forming cracks.

In the Electrochemical Industry C. V. Slocum describes results obtained by adding ferro-titanium to various classes of steel. The titanium alloy contains 10 to 15 per cent Ti, 5 to 7 per cent C, less than 0.5 per cent other impurities, the balance, about 80 per cent, being iron. This alloy is made in the electric furnace. In Bessemer practice the alloy is added after the Mn, while the steel is flowing into the ladle. After this addition the metal is held 3 to 15 minutes before teeming. There is an increase in the amount of slag removed from the metal, which latter lies "dead" in the ingot molds, and the steel is free from blowholes. In open-hearth steel the effects of the treatment are freedom from blowholes and pinholes, increases in elastic limit, reduction of area, etc. Open-hearth castings from metal treated with the alloy are more blue in color, free from brittleness, more easily machined and heat less under the tool, hence may be machined more rapidly than other steels of the same carbon content. In the crucible the alloy has been found to increase the strength of Ni and Cr-Ni steels, acting as a powerful deoxidizer. In chilled castings 1 per cent of the alloy increases the crushing strength nearly 100 per cent, and gray-iron castings from 20 to 40 per cent. In dies and die blocks the alloy gives great resistance to shock, with consequent increase in life. No reduction of the P and S contents of the steels has been found by the use of the alloy, but it is claimed that by its use the obnoxious effect of these impurities is reduced. On being added to molten iron or steel the Ti unites with the O and N in the metal, increasing its temperature some 30 deg. to 50 deg. Aluminium must not be used in any case with the Ti alloy, and the proportion of ferro-silicon should be decreased and sometimes entirely eliminated. When dirt specks are found in the surface of the treated steel the amount of ferro-manganese should be increased by about 10 per cent. The percentage of alloy to be used varies with the grade of the iron to be treated and the results desired. Ordinarily 0.1 per cent Ti is a good proportion. The Ti itself passes off with the slag which it removes, unless excess be added, when this will be found in the steel.

SCIENCE NOTES.

Metallic chromium, states the Brass World, is now a commercial article, and can readily be obtained of high purity and at a reasonable price. As far as known, it has not yet become a constituent of the non-ferrous alloys, although it has long been used in making very hard and tough steels.

Seismometers, or seismographs, as they are more generally termed, are instruments for detecting or measuring the earthquake shock or wave. Some of the modern ones are extremely delicate and sensitive, so sensitive in fact, according to Milne, that if the solid column of masonry communicating with the rocky floor be pressed with the hand, the seismograph which rests on the masonry will be affected, and the horizontal boom or pendulum will be set in rapid vibration. If two Milne seismographs provided with horizontal pendulums be put on high buildings opposite each other on one of London's traffic streets when crowded with heavy drays, they will show that the tops of the buildings bend over slightly toward each other.

Cement makers' itch is a new disease of occupation, and is entirely distinct from ordinary itch. It is neither parasitic nor contagious, but is produced by the chemical or mechanical action of the cement upon the skin. The corrosive action has been attributed by some physicians to calcium carbonate and to sulphuric acid. Fresh cement, however, does not contain any calcium carbonate, and it is questionable whether slaked lime, or even partly slaked lime, will produce this effect, for masons working with lime mortar are very seldom, if ever, attacked with cement makers' itch. The quantity of sulphuric acid in cement is very small. Possibly the effect may be explained by mechanical friction between the skin and very fine but very hard particles of cement. Briquette makers are subject to a similar but less serious annoyance. Cement makers' itch and ordinary itch have one symptom in common; namely, intense itching, especially at night. The itching appears to be increased by the heat of the bed, and is also more annoying in summer than in winter. The natural attempt to attain relief by scratching may produce infected wounds, swelling of the hands and other troubles. Cement makers' itch is always an occupational disease, while true itch is very seldom such; for example, in the case of persons who handle textile fabrics coming from India, which have not been disinfected and contain parasites. True itch can be cured by one or two treatments. This is not the case with cement makers' itch, which is sometimes followed by eczema or other complications. The managers of cement works should always require their workmen to wear cotton gloves, and garments tightly fastened at the neck and at the wrists. Men working at arches or ceilings, and liable to have the cement come in contact with their faces, should wear masks. Both gloves and masks should be washed very frequently.

The pendulum observations made in India, in 1902, by Col. Burrard, revealed a surprising fact. The deviation of the pendulum from the vertical by the attraction of neighboring mountains had long been known. From the deviation thus produced by Mount Schehallien, in Scotland, Maskelyne, in 1775, deduced the value 4.8 for the mean density of the earth. (The mean value obtained by various methods in more recent and more accurate investigations is 5.5.) Col. Burrard, however, observed deviations that could not be accounted for by visible mountains. The northward deviation of the pendulum, caused by the Himalayas, diminished as the distance south of those mountains increased. But, as the observations were extended still farther southward, the northward deviation was succeeded by a deviation toward the south, which increased, attained a maximum, diminished, and was finally succeeded by a new deviation toward the north. The changes in the deviation of the pendulum were such as would have been expected if the observer, in his southward journey, had crossed a second range of mountains, instead of traversing the vast plain of northern India. In order to account for the fluctuations, and especially for the very rapid diminution of the northward deviation as the distance from the Himalayas increased, a local diminution of density beneath these uplifted masses has been assumed. Col. Burrard explained the subsequently observed southward deviation by assuming the former existence of a mountain range, now obliterated, extending parallel to and from 250 to 350 miles south of the Himalayas. This view is sustained by observations made since 1904, along two lines perpendicular to the axis of the Himalayas, and extending, respectively, from Chatra to Sandakphu and from Amritsar to Multan. These observations indicate that a part, at least, of the southern deviation found 250 miles south of the Himalayas, can be explained by the existence of a buried mountain range, but that it is also necessary to take into account the deep depression of the land observed between the Himalayas and this hypothetical buried range.

TRADE NOTES AND FORMULÆ.

Method of Preventing the Guttering of Candles while Burning.—Lay the candles in a mixture of 15 parts each of sulphate of magnesia and dextrine and 100 parts of water. The solution dries quickly and does not affect the burning.

Cementing Wood to Tin.—Melt in a thick-walled, iron vessel, 1 part of yellow wax, and stir in 2 parts of gutta percha shavings, 2 parts of shellac and 0.1 part of boiled linseed oil, until complete solution is obtained. As soon as the mass has cooled, it is poured onto a somewhat moistened metal or stone surface, then kneaded and formed into sticks. The wood and tin parts to be cemented are thoroughly dried and the melted cement applied evenly to wood and tin; the parts thus cemented are kept pressed moderately together for 24 hours. The cemented articles are dried in a not too cool workshop.

Laundry Marking Paste.—30 parts sulphate of copper and 30 parts hydrochloric aniline are separately rubbed down fine, then carefully mixed together, after which 10 parts of dextrine are added. The mixture is then rubbed down with 5 parts of glycerine and enough water to produce a thick, uniform paste-like mass, which is available for immediate use. For this purpose we proceed, with the aid of a stencil and bristle brush, as usual. After marking or stenciling, the articles are left at least 2 to 3 days without ironing them, after which the lettering shows in dark green color which, after washing with soap or soda, turns a deep black. The marking paste may be kept for a long time, only, in case it dries, with the brush containing a little water, enough of the paste must be rubbed off so that the letters, immediately after marking, appear in a greenish color. The black color, secured with a paste of this character, is identical with aniline black and consequently possesses the same capacity for resisting re-agents as the latter. If it is desired to transform the paste into a marking ink, it is only necessary to pour a little water on a portion of it; the turbid fluid thus obtained can be used at once as a laundry marking ink. As a general rule, however, the use of the paste, in the manner described, will be more practical, because in this manner cleaner and sharper outlined letters are insured.

Artificial Whalebone.—This material is easiest made from raw animal skins. These are first treated with sulphide of sodium and the hair removed. The skin thus prepared is placed for 24 to 36 hours in a weak solution of bichromate of potash. To dry the skin thus prepared, it can be stretched or tacked on a frame, a flat plate, or any similar contrivance, so that in drying, the skin cannot shrink and to insure its drying as flat as possible. On these frames, the skin, exposed to the effect of daylight, is dried, at first slowly and then exposed to a temperature of 122 deg. to 140 deg. F. The action of the daylight, in combination with the bichromate of potash the skin now contains, makes the glue present in the skin cells insoluble in water and prevents the occurrence of putrefaction, while the vigorous drying removes the moisture from the innermost core of the leather. The dried skin is then compressed under very heavy pressure, and the material thus obtained possesses a hardness and elasticity closely approaching that of the genuine whalebone. This material, before or after drying, can, by coating or immersion in a bath of color, be colored as desired in order to impart to it the color of the natural whalebone. It is made better capable of resisting moisture by coating or impregnation with rubber, varnish, lacquer or similar substances. Where rubber is used, it can be either applied directly or in the form of a casing or covering, drawn over each piece or rod. The separate rods may also be protected from moisture by inclosure in waterproof paper or waterproof fabric. This artificial whalebone can also be made from more or less tanned leather, which, for this purpose, is treated like the untanned skin. When the artificial whalebone is completed, it is cut into plates of any desired length and width. The product may also be given a rounded form by pressing.

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